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ENVIRONMENT AND NATIVE SUBSISTENCE
ECONOMIES IN THE CENTRAL
GREAT PLAINS

(WITH FIVE PLATES)

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ENVIRONMENT AND NATIVE SUBSISTENCE ECONOMIES IN THE CENTRAL GREAT PLAINS

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(WITH FIVE PLATE(S))

During the past 10 years an increasing interest has been manifested in the relations of man to environment in the Great Plains. Widespread droughts, spectacular dust storms, and recurrent crop failures are driving home again a fact which had been largely forgotten during the preceding prosperous decades—namely, that the climatic fluctuations to which the region is subject can be of sufficient magnitude to render man's occupation precarious. Numerous farms have been abandoned, and there is a rather general belief that much of the land is wholly unsuited to agriculture. Students of ecology and geography, recalling similar happenings in the past, have been insisting again that a long-range program of land utilization in place of the present haphazard methods would make possible the recovery of much of the supposedly worthless area.

It is not my intention here to suggest a cure for the economic problems arising from the conditions just noted, but rather to examine certain pertinent facts brought out by recent archeological investigations. We know now that long before white explorers ventured into the Great Plains, the region had been exploited in different ways by various native peoples. There is a growing belief that some of these aboriginal groups may have had to cope with adverse climatic conditions similar to those faced by man here today. The evidence is still fragmentary and scattered, because the area involved is enormous and the workers are few. Still, it may be worth while to indicate the directions in which the available data appear to lead.

For present purposes the central Great Plains comprise the area included in the States of Kansas and Nebraska. We shall review briefly the environmental setting as a background for an outline of the historic and prehistoric native subsistence economies. This will be

followed by a consideration of the possible significance of certain inferred climatic variations upon past human populations.¹

ENVIRONMENTAL FACTORS

To the casual observer traveling across Nebraska and Kansas along the main thoroughfares, the region exhibits a rather wearisome uniformity. In broadest outline it is a land of low relief, few trees, and little rainfall—of sun and wind and grass. A closer regard for the details of topography, native flora and fauna, and other aspects of the environment will show, however, that there are a number of natural variations (see Shelford, 1926, and Fennemman, 1928) which bear on man's utilization of the land.

The western portion of the area is a part of the High Plains province (fig. 1)—the remnant of a great outwash plain which in Tertiary times reached from the mountains into eastern Nebraska and Kansas. The High Plains are characterized by broad, monotonously flat upland areas which, toward the north, tend to become uneven or gently rolling. Rivers heading in the Rocky Mountains, such as the Arkansas and Platte, flow eastward across this belt in wide, flat-floored valleys. Lesser streams rising within the High Plains occupy shallow, open valleys which in places give way to picturesque rock-walled canyons. Where the secondary valleys have been cut through the unconsolidated Tertiary silts, sands, and gravels into the impervious underlying formations permanent springs occur. These give rise to perennial creeks flowing in verdant valleys which contrast strikingly with the surrounding uplands and which, since time immemorial, have provided ideal camp and village locations for primitive man (pl. 3). Where not under cultivation, the uplands are dominated by buffalo and grama grasses, with yucca, cactus, and sagebrush locally abundant. In the valleys there are groves of hackberry, cottonwood, and willow, with some elm and ash. Thickets of wild plum, elderberry, and other edible native plants are scattered along the ravines and stream valleys. Juniper grows along the valley rims, and in parts of Nebraska there are stands of western yellow pine. Native fauna included notably such animals as the bison, antelope, mule deer,

¹For helpful information and stimulating suggestions as this study developed, I am particularly indebted to Dr. C. E. Leighty, J. S. Cole, and O. R. Mathews, agronomists at the Division of Dry Land Agriculture, Bureau of Plant Industry, U. S. Department of Agriculture; and to Harry E. Weakly, junior agronomist at the North Platte Experimental Substation of the College of Agriculture, University of Nebraska.

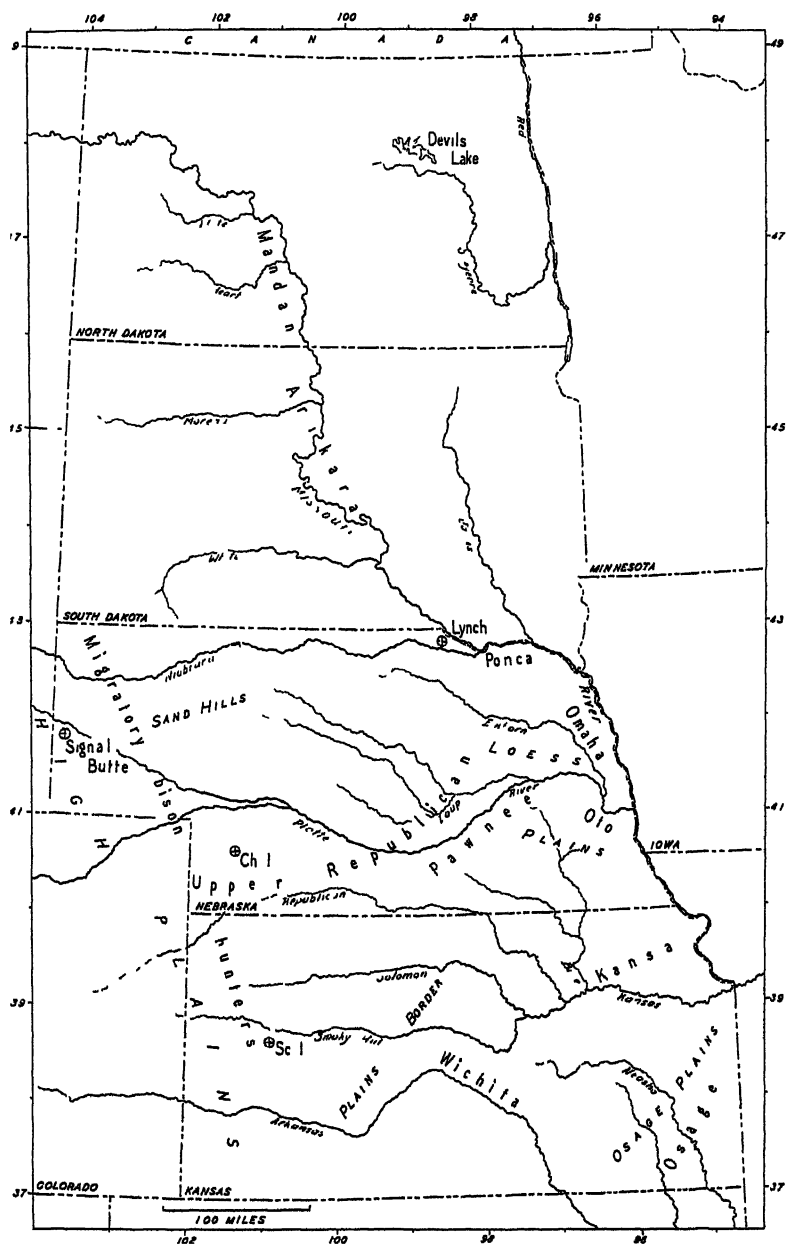


FIG. 1.—Map of the central Great Plains and upper Missouri Valley, showing physiographic divisions, tribal groups, and archeological sites considered in the present paper.

prairie dog, coyote, black-footed ferret, jack rabbit, badger, and smaller forms, and game birds such as prairie chicken and grouse.

East of the High Plains there is a marked change in the terrain. North of the Platte River in Nebraska are the Sandhills, a rough, hilly area dotted with ponds, lakes, marshes, and hay flats. The hills are in reality sand dunes which are held fast by a cover of bunchgrass interspersed with yucca and cactus. Trees are scarce except in the vicinity of ranch buildings. There are few streams, but those which head in the region, notably the several forks and upper tributaries of the Loup, carry an abundance of excellent water throughout the year. They head in shallow, grassy swales which soon give way to deep canyons lined with deciduous timber, plum thickets, and other vegetation.³ Wild rice grew in some of the shallow lakes and was an important native food item (Gilmore, 1919, p. 67). Beaver, muskrat, deer, and smaller mammals inhabit the valleys; coyotes and jack rabbits abound; and great numbers of waterfowl still have their nesting grounds about the lake margins. Like the High Plains, the Sandhills are a region of low rainfall. Since the soil is loose and sandy and tends to blow readily when the sod is removed, large-scale agriculture is impracticable and cattle raising is the principal activity today.

South of the Republican River, in north-central Kansas, the eastern front of the High Plains has been dissected by stream erosion to produce the so-called Plains Border. This is a belt of high plateaus and prominent east-facing escarpments cut through by the deep, broad valleys of the Smoky Hill, Saline, Solomon, and their tributaries. Buttes and ridges are a conspicuous feature of the landscape. The fertile river valleys are fringed with forests of oak, elm, ash, walnut, cottonwood, and other hardwoods, and bluestem and bunchgrasses formerly clothed the upland areas. Native fauna included all the larger forms found on the High Plains together with numerous other species more typical of areas to the east.

³ In 1895 Bessey (1896) observed that relict stands of western yellow pine were to be found in the canyons along the Niobrara River as far east as Holt County, along the North Platte and Lodgepole Rivers to Lincoln County, in widely isolated canyons in Valley, Custer, Greeley, and other Counties in central Nebraska, and along the Republican to the vicinity of Franklin. These localities lie for the most part west of the 99th meridian. Husson (1896) also calls attention to the fact that "yellow pine grew formerly in and along the canyons south of the Republican River in Franklin County . . ." Early settlers cut the larger trees for fuel and posts, and transplanted the smaller ones to gardens and lawns. Bessey held that these distributions were best explained "by supposing that the central region was once wholly or in part covered with forests."

East of the Sandhills and Plains Border provinces the Great Plains give way to what was formerly a bluestem and prairie-grass region. In eastern Nebraska the Loess Plains present a flat to rolling or hilly terrain. A thick mantle of loess extends from the Missouri Valley westward to the Sandhills and, as a narrower band, between the Platte and Republican Valleys to the High Plains in southwestern Nebraska (pl. 4, fig. 1). To the southeast it merges into the unglaciated gently rolling Osage Plains lying south of Kansas River. Throughout all this region, the streams run in broad, bluff-lined, often terraced, valleys. Fine stands of burr oak, elm, walnut, hickory, sycamore, and other hardwoods skirt the streams. Edible plants include the wild grape, plum, chokecherry, mulberry, and a number of tuber-bearing forms (see Gilmore, 1919). Other items which unquestionably figured in aboriginal economy were the Osage orange or bois d'arc, papaw, pecan, and persimmon, all found in eastern and southeastern Kansas. Bison, elk, antelope, and deer found unlimited pasturage in the valleys and on the deeply grassed uplands. Wolves, coyotes, badgers, and rabbits were plentiful; along the streams were beaver, bear, otter, raccoon, cougar, opossum, wildcat, fox squirrels, and a host of lesser forms. Most of these followed the wooded valleys westward far into the plains. Permanent streams are, or were, the rule, and fine springs formerly abounded on the larger as well as on many of the lesser watercourses. Precipitation, except in the west, is ample for agricultural needs, and the soils everywhere are deep, rich, and easily worked. Today this is the most densely populated and the finest agricultural land in the central Great Plains.

The Loess Plains are flanked by a narrow strip of rugged hills on the east where short, deeply incised creeks and narrow, heavily timbered ravines empty directly into the Missouri River. Broadleaf forests and dense thickets were formerly dominant, and the district abounded with game and other wild-food resources. Historical accounts indicate that the lofty bluffs fronting on the Missouri were bare of trees during the early nineteenth century, but the valleys must always have been well wooded.

From the standpoint of agriculture, whether modern or aboriginal, probably the most important factor in utilization of the Great Plains by man is climate (Kincer, 1923, and Climatic summary of the United States, sections 38-41). The region as a whole is characterized by warm summers with abundant sunshine; by winters that are cold and dry; and by considerable windiness throughout the year. In the central portion, as we have defined it, there is a frost-free growing

season of 150-200 days, sufficient to mature most cereals and vegetable crops. Precipitation decreases markedly from an annual total of about 40 inches in southeastern Kansas to 15 or 18 inches in western Kansas and Nebraska. Because of the dry winters, the moisture stored in the soil is generally scanty; hence crops depend chiefly on the rainfall during the growing season. In this respect, the average annual precipitation shows a favorable distribution, since about 70 percent or more falls between April and September.

As Smith (1925, p. 413) has pointed out, "averages do not tell the whole story. Averages rarely happen. The freaks of the season decide man's chances . . ." In the Great Plains, the minimum precipitation required for successful agriculture by ordinary methods is somewhere between 15 and 20 inches annually. This means that over much of the region, particularly west of the 98th or 99th meridian, the yearly average is very close to the minimum required for successful crop growth, and hence that the year to year variation is of very great importance. A decrease in rainfall of only a few inches, particularly if continued for several years, may result in a major disaster for the grain farmer.³ Furthermore, long-time weather records show that in the western Great Plains "there is less than the normal amount of rainfall in more than half the years." Farming except by specialized methods is rendered still more precarious by the fact that there may be several seasons of deficient moisture. These fluctuations are of variable duration, do not come in regular succession, and cannot be forecast with any accuracy.

The character of the summer rains must also be considered. In large part, they come as thunderstorms, often of great violence and short duration. Downpours of 3 to 6 inches within a 24-hour period have been recorded at many points, this sometimes exceeding in amount the normal precipitation for the month in which it occurs. The rains may come with such force that the ground surface is puddled, so that most of the water runs off before it can be absorbed

³ The delicate balance between yearly rainfall and crop yields in this western area has been strikingly demonstrated by Cole (1938). From weather and crop records for 14 stations in western Nebraska, Wyoming, North and South Dakota, and Montana, he has determined the mean precipitation and mean average yield of spring wheat over periods varying in length from 10 to 28 years. With an average precipitation of just under 15 inches, the average wheat yield was slightly over 15 bushels per acre. When average precipitation fell 20 percent to 12 inches, wheat yield dropped nearly 50 percent to a trifle over 8 bushels. A further lowering of precipitation to 50 percent of normal thus resulted not in a half crop but in no crop at all. No comparable statistics are available on rainfall and corn growth in this region, but a similar correlation may be suspected.

by the soil. These storms, furthermore, are mostly local, with short, erratic courses that may leave one small area drenched while surrounding sections receive little or no moisture. Similar local differences are reflected in the annual precipitation records from time to time. Thus, in 1875 and again in 1901-3 inclusive at Dodge City, Kans., annual precipitation was from 50 to 90 percent of normal (average, 19.9 inches); but during the same years at Hays, 85 miles to the north, there was an excess of moisture ranging from 5 to nearly 50 percent (average, 21.28 inches).

Droughty conditions in summer are often attended by prolonged periods of high temperatures. Southerly winds predominate; being warm, they have a drying effect, and their high velocity favors rapid evaporation. Particularly destructive are the so-called "hot winds" which may accompany shade temperatures of 100° to 110°. They have been likened to a blast from a hot furnace, and frequently cause much damage to crops and serious discomfort to animal life. Immense havoc may be wrought in a few hours if these winds occur at critical stages of crop development, and when they continue for several days man and beast alike suffer intensely and widespread crop failures result. Many farmers insist that these hot winds can kill the corn crop even when through subirrigation or otherwise the soil is moist enough to meet the normal requirements of the growing plants. I am not certain, however, that this view has general acceptance among impartial observers.

HISTORIC SUBSISTENCE ECONOMIES

The 99th meridian, lying somewhat east of the line of 20-inch annual precipitation, may be regarded as the approximate dividing line between the Great Plains on the west and the true prairies or prairie plains on the east. It will serve also as the line of demarkation between two strikingly divergent native subsistence economies in the central Great Plains during the nineteenth century. To the east, where soil and especially climatic conditions are today recognized as most favorable for farming, the native economy was based on horticulture with hunting secondary. West of this line, where bitter experience has since shown the white settler that agriculture is likely to be a highly uncertain venture, hunting was of primary importance.

The principal natural game resources of the High Plains have already been noted. What they may have lacked in variety was more than offset by the abundance of certain species. During the nineteenth century the High Plains and the Plains Border immediately to the

east were preeminently the range of the great bison herds. Parasitic on these were several Siouan, Algonquian, and Shoshonean Indian tribes whom we may term the migratory bison hunters (fig. 1). North of the Platte were the Dakota bands; farther south was the habitat of the Cheyenne, Arapaho, Comanche, and Kiowa. Throughout the spring, summer, and early fall organized bands of these Indians hung about the flanks of the herds, subsisting chiefly on the flesh of the bison and drying large quantities of meat for winter use. In winter the roving village units usually returned to certain sheltered spots which because of water, wood, and forage for horses were used year after year. Large herds of horses were to be seen at every camp. The portable skin tipi was universally used (pl. 1). Skin working was highly developed; otherwise, implements, utensils, and industries were limited to essentials which could be moved easily and conveniently on horseback from camp to camp. Surplus foods were stored in skin containers. Agriculture was nonexistent, as was the potter's art. The gathering of quantities of wild fruits, nuts, berries, and starchy roots and tubers supplemented the chase (Carlson and Jones, 1940); maize was obtained by trade or theft from settled horticultural tribes. An elaborate militaristic system had been built up, and much of the time not occupied in food getting was given over to warfare and horse stealing. These peoples recognized no definite tribal boundaries, and the distances traveled by them during their annual hunting trips and in raiding forays frequently totaled many hundreds of miles.

East of the 99th meridian, since the coming of the white man, have dwelt chiefly Siouan- and Caddoan-speaking tribes. Eastern Kansas was held by the Osage, northeastern Kansas by the Kansa, eastern Nebraska by the Oto, Missouri, Omaha, and Ponca. Farther to the west, on the Loup, Platte, and Republican Rivers, stood the villages of the Pawnee, a confederacy of Caddoan tribes whose nearest kindred linguistically were the Arikara in South Dakota. At the dawn of the contact period, the Wichita are believed to have had a group of settlements in central Kansas in the vicinity of the great bend of the Arkansas. These were abandoned during the eighteenth century for other lands farther south. The rest of the tribes enumerated remained in their respective locations until reservation days a century or so later.

All these tribes dwelt in large fixed villages situated near streams where wood, permanent water, and arable ground were to be had. Habitations were circular earth-covered or grass-thatched lodges (pl. 2). Subsistence was based primarily on the cultivation of maize, beans, and squash, to which were added a long list of wild berries,

fruits, and tubers (Gilmore, 1913, and 1919). The latter included wild plum, hackberry, chokecherry, sand cherry, wild potato (*Ipomoea pandurata*), ground bean (*Apios tuberosa*), the pomme blanche (*Psoralea esculenta*), and others. Of considerable importance, too, especially after acquisition of the horse about 1700, were the products of the chase. Bison were the principal game animal, and to obtain them one or two well-organized hunting trips were made annually into the western plains. The Omaha and Ponca hunted north of the Platte into the Sandhills; the Pawnee went either up the Platte and Republican Valleys, or else shared with the Kansa and Osages the Plains Border and adjacent regions in central Kansas. At such times the entire population of the villages excepting the very young, the senile, and the decrepit moved en masse, dwelling in portable skin tipis and hauling their impedimenta on horseback or by travois, and living in general like the migratory bison hunters. At the temporarily deserted villages, the possessions which could not be carried along were concealed in underground pits. Under aboriginal conditions all these groups made pottery, and possessed in addition well-developed industries in stone, bone, horn, shell, and other materials. Whereas the temporary campsites of the migratory bison hunters today show little evidence of occupancy beyond hearth areas and possibly a few stone implements and animal bones, the abandoned house sites, cache pits, and accumulated refuse deposits of the village dwellers usually yield a rich harvest for the archeologist.

Fundamentally, the native agriculture of the Great Plains was of southeastern type, with tillage mostly or entirely by the hoe. The old type of hoe consisting of a bison shoulder blade lashed to a bent or forked stick survived until very late times, being used side by side with iron tools supplied by the traders. The fields—more accurately described as gardens—were small, ranging in size from $\frac{1}{4}$ to 3 or 4 acres. No attempt was made to break out the tough sod of the uplands. In the valley bottoms, the plantings were confined to little patches of loose alluvial soil scattered along the creek banks or lying at the mouth of a ravine. Because such spots were usually limited in number, the women often found it necessary to travel from 5 to 10 miles to and from their gardens. Corn, beans, and squash were the principal crops, but sunflowers, tobacco, and watermelons were also grown (Gilmore, 1913, p. 322). Women did all the planting and cultivating. Fertilizers were unknown and there is no evidence that irrigation was attempted. It is not definitely known whether the Indians of the central Great Plains had developed special deep-rooted, early-maturing, or drought-

resistant varieties of corn, as had the Mandans of the upper Missouri (cf. Will, 1922), but it is quite possible that in the course of years some selection of this sort had taken place.

The fields were ordinarily hoed only once or twice. After the second hoeing, in June, the entire population of the village set out on the summer hunt, returning in September to harvest the crops. Surplus corn was boiled, cut from the cob, and dried, and then stored in underground caches. These caches, when emptied of foodstuffs or when rendered unfit for further use by spoilage of their contents, were abandoned, often to be refilled with refuse. Such pits are a common feature of every village site so far excavated in the central Great Plains where horticulture is evidenced. In the early historic villages of the Pawnee along the Loup and at the contemporary Wichita (?) sites in central Kansas, these caches are often 6 feet deep, and they have been known to attain a depth and a diameter of 10 feet or even more. At later sites, particularly in those dating after 1800, caches seldom reach these dimensions. It is not yet clear whether this decrease in size reflects smaller crops due to a slackening interest in farming and a correspondingly greater reliance on hunting or is attributable to some other factor.

The Pawnee and Omaha used an upright wooden mortar with pestle for grinding corn; their protohistoric contemporaries in central Kansas used the flat or hollowed stone mealing slab with muller.

ARCHEOLOGICAL CONSIDERATIONS

As systematic archeology adds perspective to our picture of native life in the central Great Plains, it becomes increasingly clear that the two fundamental economic patterns outlined above, or variants thereof, have long been present locally, but that man's emphasis has shifted back and forth from one to the other. As Kroeber (1939, pp. 76-79) has indicated, ". . . the historic Plains [horse] culture was a late high-pressure center of culture in a region which previously had been rather conspicuously low-pressure." He is undoubtedly correct, too, when he observes further that in the prehistoric period, prior to the sixteenth century, the plains were a cultural margin. By comparison with the eastern Woodlands and the Southeast, where advanced mound-building civilizations once flourished, the region west of the Missouri is characterized by antiquities of quite unspectacular nature. Temple mounds, for example, are nonexistent; and the practice of raising tumuli over the dead, which serves to emphasize the highly elaborated burial cults of the east, extends only a little way into the

prairie plains of eastern Kansas and Nebraska and is not indicated at all for the plains proper.

The admittedly marginal nature of the semisedentary village cultures in historic times, together with the nomadic mode of life followed by the "typical" plains tribes farther west, has tended to obscure certain facts relating to the earlier agrarian peoples in the area. Kroeber (op. cit.) states that "It is scarcely contendable that the western plains were wholly uninhabited before the horse was available. Agricultural groups from east and west probably strayed in now and then and tried to farm. Small groups could make a living by combining bison and river bottom hunting with berry and root-gathering . . ." Archeology shows that primitive maize growers from the east had indeed penetrated far beyond the western margin of the prairie plains and had established themselves along many of the stream valleys in the High Plains. Their settlements were much smaller—and far more numerous—than those of such historic village tribes as the Pawnee. It is hardly accurate to speak of these prehistoric groups as mere "strays," for they came and spread in sufficiently leisurely fashion to scatter their remains along almost every arable stream valley with reasonably sure water as far west as the Colorado line. The diffuse nature of this early occupancy is in striking contrast to that of historic times when such tribes as the Pawnee dwelt in a very few large compactly built towns within a few miles of one another.⁴

Strong (1935) was the first to point out clearly that in the light of archeology the limitations of environment in the Great Plains were not so severe as many have been led to believe. In the long-range view, the droughts, excessive temperatures, and searing winds, which have played havoc with the present-day farmer and his commercial ventures, are comparatively transient if recurrent phenomena. Under normal climatic conditions the region is less hostile. Some degree of success, at least, must have attended the efforts of the native peoples who, content with a subsistence agriculture, ventured to try their hand at wresting a living from the soil of the short-grass plains.

As an example we may cite the recent discovery of pottery-bearing sites yielding definite proof of native farming activities in Chase

⁴ The Pawnee after 1800 were variously credited with 5,000 to 12,000 persons. I suspect that if these were redistributed among the older sites, many of the latter would be decidedly underpopulated. Even granting that not all the small prehistoric sites were inhabited synchronously, I am of the opinion that there may at times have been about as many Indian farmers in prehistoric Nebraska as there were during the nineteenth century. A very considerable proportion of these, moreover, lived in the High Plains area.

County, Nebr. (see fig. 1, Ch: 1), and in Scott County, Kan. (fig. 1, Sc: 1).⁵ These sites lie near the 101st meridian, 300 miles or more west of the Missouri, and well within the dry High Plains province (pl. 3). Both have yielded charred corn, together with bone hoes made from the scapula of the bison. At the Scott County site (pl. 3, fig. 1), where certain puebloan influences suggest the possibility of irrigation, the remains of squashes or gourds were also found. The great abundance of animal bones, as well as the very limited positive evidence of fixed habitations, leads to the belief that hunting probably ranked first in the food economy, with horticulture perhaps a side line. There is no reason to suppose that the inhabitants of these sites were related to the Pawnee or to any of the other Caddoan or Siouan village tribes of the eastern plains, or that they were directly ancestral to the Dakota, Cheyenne, and Arapaho who roamed the same area in the late eighteenth and nineteenth centuries. Scant amounts of iron trade materials indicate an early historic or protohistoric dating. The sites have been assigned to the Dismal River culture; it is possible that they will eventually be attributable to some of the semihorticultural Apache communities which according to seventeenth- and eighteenth-century Spanish documents formerly lived in the bison plains. At present they represent the westernmost points at which maize specimens have been reported archeologically in the central Great Plains.

In an earlier period, before any European influences had yet reached the area, horticultural peoples of another sort dominated the central Great Plains. Most widely distributed and best known are those who left the remains comprising the Upper Republican culture (Strong, 1935, pp. 69-124, 245-250, 275-278; Wedel, 1935, and 1940b, pp. 310-312; Champe, 1936). These remains occur throughout the Loess Plains to the edge of the Sandhills and south to the Smoky Hill-Kansas River drainage, with a westward extension far up the Republican (pl. 4, fig. 1) and Platte basins.⁶ They consist of innumerable small village sites situated near former springs or other permanent water on the flood-free terraces which characteristically border many

⁵ Wedel, 1940a; unpublished field notes by A. T. Hill, Lincoln, Nebr.

⁶ It is interesting to note that in terms of present-day agricultural regions, the village sites of these prehistoric agrarian peoples are most plentiful in those portions of Nebraska and northern Kansas which are assigned to the Corn Belt (see O. E. Baker's map in *Atlas of the Historical Geography of the United States*, pl. 142A). Their range also includes adjacent districts in northern Kansas now given over to hard winter wheat. From surface finds of pottery, it appears that they may have inhabited the present corn-wheat zone in northeastern Colorado.

of the creek valleys. The villages included from a half dozen to two or three dozen rectangular pit houses scattered over several acres of ground. Unlike the historic Pawnee villages, these earlier communities were apparently unfortified. Cache pits are present in all these sites; they seldom exceed 3 or 4 feet in greatest depth and diameter, and thus average much smaller than those of the early historic Pawnee. In them are found charred maize, beans, animal bones, pottery, stone and bone artifacts, and other evidences of human industry. Universally present is the bone hoe. Charred corn, cobs, and beans have been found in these sites as far west as Medicine Creek in Frontier County, Nebr. Typical pottery, together with evidence of earth-lodge remains, occurs still farther west in Chase County, and excavation will probably show that the occupants of these villages also practiced farming. Inferentially, this must have been on a small scale and by methods closely similar to those described above for the Pawnee and their neighbors. The hoe, and also the crops evidenced through archeology, all have historic counterparts. Since the prehistoric villages were much smaller, it can be assumed that sufficient arable ground was available in the bottom lands close at hand. The horse was unknown, but since the villages were scattered widely over much of the choicest bison range it is probable that ample supplies of meat could be obtained by foot hunters whenever desired. At any rate, the bone refuse in their sites shows that the Upper Republican peoples relied probably more on the bison than on any other single species for meat.

A somewhat variant contemporaneous manifestation along the Missouri River bluffs has been termed the Nebraska culture. Here, too, are found rectangular earth lodges, cache pits, pottery, and other evidences of a settled horticultural mode of life. Animal bones indicate that white-tailed deer, elk, and smaller mammals figured much more heavily in the native diet than did the presumably more distant and less easily obtainable bison. In this respect the nonequestrian prehistoric inhabitants of the immediate valley of the Missouri differed from the historic Siouan tribes who, mounted, could and did travel hundreds of miles westward in quest of the bison.

Underlying the widespread Upper Republican and contemporaneous manifestations are other pottery-bearing horizons. Remains designated as Woodland are found in small obscurely situated sites which have so far received scant notice from archeologists. In the ravines of eastern Nebraska they occur as artifact-bearing occupational strata exposed in newly cut banks, with an overburden that varies from 6 to 25 feet or more (pl. 5, fig. 1). Farther west, as in the High Plains

of Lane County, Kans., and elsewhere, similar strata are often overlain by wind-blown soils. It is still uncertain whether these overlying materials represent short cycles of abnormally heavy precipitation (in the east) or of excessively dry, windy conditions (in the west), or are due to slower but long-continued erosional processes. The extent to which the Woodland groups depended on cultivated crops is also a question since the sole evidences yet reported of horticulture—at the Walker Gilmore Site in Cass County, Nebr.—involve only the squash and gourd (Strong, 1935, p. 193).

Apparently contemporaneous with the Woodland sites are others along the Missouri in northeastern Kansas and nearby Missouri, which show a close similarity in several respects to the Hopewellian remains of the Mississippi-Ohio drainage. Evidence of horticulture is generally wanting throughout the Hopewellian horizon in the eastern United States, but it has been postulated that such an economic basis would have been necessary to so highly developed a civilization (Setzler, 1940, p. 262). At any rate, the only Hopewellian-like village site so far investigated seriously on the Missouri yielded direct proof of horticulture in the form of charred maize and beans (Wedel, 1938, p. 101). The bone hoe is absent, probably having been replaced by implements of stone or other material. To what extent the local economy was based on gardening is not clear, but cache pits possibly for storage of domestic crops were relatively plentiful. These yielded considerable quantities of deer and raccoon bones, but almost none of the bison. Since this complex does not appear to have penetrated very far west beyond the Missouri it is of minor interest so far as primitive horticulture in the Great Plains is concerned.

The prehistoric potters and farmers of the central Great Plains are thought to have moved into the region from a general easterly direction. If the Woodland peoples practiced horticulture, as we know the later Upper Republican groups did, then at least two principal waves of immigration by native farming economies are indicated. How long the interval separating these two is we do not know; there is no clear proof that the Upper Republican developed directly out of the Woodland, though some contact between the two is indicated (cf. Wedel, 1940b, p. 346). Both groups spread westward into the High Plains, nearly or quite to the present Colorado line. There is no way of telling whether either found the western plains uninhabited. It is abundantly clear that hunting economies had occupied much of the region at a far earlier time, as shown by the presence of Folsom, Yuma, and other ancient nonagricultural remains. Since hunting tribes again

controlled the area in historic times, it can be inferred that occupation by native subsistence economies based on maize constituted a relatively brief interlude which was preceded and followed by very much longer periods of occupancy by nomadic or seminomadic bison hunters.

The first Spanish explorers to visit the western plains in the sixteenth century found them occupied by nomadic Indians who had "no other settlement or location than comes from traveling around with the cows." In terms of modern linguistic groups, these are thought to have been Athabascans, probably Apache or Lipanan (Harrington, 1940, p. 510). Just when they arrived is not clear, but by 1541 the little farming communities over most of the Upper Republican area had evidently been given up. At any rate, there is no mention in the narratives of the Coronado or subsequent expeditions of anything corresponding to the Upper Republican village sites as these have been defined by archeology. The first permanent settlements seen by the sixteenth-century Spaniards in what is now central Kansas were large, some of them estimated to number 200 houses (Winship, 1896). The houses were of straw, and the natives are described as having corn, beans, and melons. All of this is reminiscent of the large protohistoric villages found in Rice and McPherson Counties, Kans. Insofar as it concerns fixed villages of horticultural peoples it also calls to mind the great fortified towns of the protohistoric Pawnee on the Loup River in Nebraska—possibly the Harahey of Coronado's chronicles (see Lesser and Weltfish, 1932, p. 12). Farther west, according to these explorers, were only migratory hunters whose mode of life was essentially the same as that of the historic hunters except for innovations taken over by the latter from white men. The cause or causes for the observed abandonment of the western plains by native farming peoples in late prehistoric times is one of the problems now confronting plains archeologists.

DROUGHTS AND PREHISTORY

Van Royen (1937, p. 637) has remarked that "there is little doubt in the minds of students of weather and climate that wide borderland areas between humid and arid regions will always be subject to recurrent droughts of varying duration and intensity, such as those experienced in historical times. Also, before the dawn of recorded history droughts occurred, some of which were brief, others evidently very long." The Great Plains constitute just such a borderland zone, with arid regions on the west and southwest and humid regions to the east. We may turn, therefore, to a consideration of certain phenomena

which suggest drought conditions during the prehistoric occupancy of the central Great Plains, keeping in mind particularly their possible effects on the native horticultural peoples.

Two sites in Nebraska are of especial interest in this respect. They are Signal Butte in the North Platte Valley near the Wyoming line, and the Lynch Site on lower Ponca Creek in Boyd County about 12 miles from the South Dakota border. Archeological remains at Signal Butte and their geologic context have already been detailed elsewhere (Strong, 1935, p. 224-239). Briefly, they consist of three prehistoric levels of human occupancy separated from one another by layers of wind-deposited loess from 18 to 24 inches thick. The topmost cultural horizon includes pottery of Upper Republican and Dismal River types, and may be no more than 300 to 500 years old. The middle and lower strata, yielding no pottery, are believed to represent much older hunting cultures. The occupational strata consist in part of humus, and presumably indicate periods of increased humidity. The intervening sterile layers are attributed to dry, windy periods. Van Royen suggests that "one or both of the sterile strata on Signal Butte may correspond to a long dry period from three to four thousand years ago or that they may be even older." Strong's estimate is more generous, with 8,000 to 10,000 years given as the possible time which has elapsed since level I (the lowest) was inhabited.

At Lynch (Van Royen, 1937, p. 638), the archeological remains cover a considerable area on the bluffs just north of Ponca Creek. As revealed in excavations by the University of Nebraska, their most striking feature is the presence of "a thick dark stratum, which near the ends of the [University test] trenches was found to lie about a foot beneath the surface and which was covered near the center by eight feet of sand. . . ." These sands, according to Van Royen, are wind-deposited, and were derived from the water-laid Pleistocene sands on the high terrace north and northwest of the areas of accumulation. The topsoil to a depth of 12 to 18 inches has been colored gray by plant matter and still supports a fair stand of grass. Wind activity here today is not great enough to produce dunes or sand drifts except where the grass cover has been killed off by cultivation or by overgrazing. The gray topsoil is too deep to be accounted for by the few decades which have elapsed since introduction of the plow in the district, and "since the culture stratum does not show any influence of the white man" it is suggested that the period of pronounced sand movement antedates the coming of Europeans. The observed conditions would imply a prolonged period of lower

rainfall and destruction of the grasses, followed by increased wind action on the denuded ground surface.

The question of dating even approximately the Indian occupation at Lynch, and through this the drought which must have followed it closely, hinges very largely on accurate identification of the archeological materials in the dark stratum. A detailed report on these has not yet appeared, but certain generalizations can be ventured on the basis of sherds collected on the surface during several visits I made before and at the time of the excavations (Wedel, 1940b, p. 317; see also Van Royen, 1937, p. 647). The sandy overburden has blown extensively wherever modern cultivation is under way, this being especially true on fields a few hundred yards east of the diggings. On the denuded village surface there were abundant remains, and hearths could be found only a few inches below the plowed topsoil. A collection of several hundred potsherds including numerous rim pieces, as well as many end scrapers, projectile points, and other chipped forms indicated an interesting mixture of types. One group of sherds exhibited features characteristic of the Upper Republican horizon; others, including a few rim pieces with handles, were reminiscent of Nebraska culture remains. A third group, in which shell tempering was noted, included incised or trailed decoration, rims, and handles resembling in most particulars the Oneota wares of the upper Mississippi and Missouri Valleys. A few sherds bore parallel ridges on their exterior surfaces, apparently produced by the same paddling technique used so widely by the Pawnee, Mandan, Arikara, and other tribes in protohistoric and historic times.

The Upper Republican and Nebraska culture manifestations throughout the central Great Plains have been extensively worked, and in no case has iron, glass, or other evidence of contact with white men been noted. On the other hand, Oneota village sites in Iowa, Missouri, and Kansas have yielded small amounts of such material. All the available evidence indicates that in the Missouri Valley and westward, the Oneota remains are late. Some of the sites may antedate slightly the arrival locally of white men, but the strikingly uniform character of the remains over most of the area occupied would indicate that they were not spread over a very long period of time.

It is not clear whether all the several pottery types noted at Lynch occur together or whether there was a stratified succession of wares. It is possible that a late phase of the Upper Republican survived here for a time alongside an unclassified peripheral variant of the Oneota

manifestation. In any case, the fact that pottery with definite Oneota affinities underlies the sand deposits is strong evidence that the latter were laid down within the last three to five centuries.

Much less striking than the sand accumulations at the Lynch site or the stratified remains at Signal Butte is the occurrence at many sites in the central Great Plains of a soil cover equally suggestive of dry, windy conditions. In a great many localities soil profiles have been partially obliterated by modern agricultural activities, but here and there in stream terraces can still be seen evidences of a dark humus zone buried under 10 to 30 inches of fine light-gray loess, without doubt wind-laid. That this old humus zone was at one time an inhabited surface is indicated by archeological observations. In the Republican drainage of southern Nebraska, as for example, on Medicine and Lost Creeks, Upper Republican pit-house sites have been found excavated into the humus line, with potsherds, bones, and similar village refuse littering the same level (Wedel, 1934, pp. 149, 152, 154; Strong, 1935, p. 76). That these houses were not dug from the present surface is shown by the presence of culturally sterile wind-blown materials which extend evenly and uninterruptedly across the old house basins and over the adjoining detritus-strewn humus zone. The present surface of this soil cover is usually flat with no suggestion of dunes or drifts. The material itself is finer than that at Lynch, and superficially resembles rather closely the sterile layers separating culture horizons at Signal Butte.

Upper Republican village sites blanketed in this fashion occur throughout the Republican River basin in southern Nebraska from Frontier, or possibly Hayes, County eastward at least to Webster County. I have observed a similar though thinner unbroken covering on Upper Republican sites in the lower valley of the North Loup River (pl. 4, fig. 2). Since widely scattered sites are thus involved the factors responsible must have been of more than local magnitude. At the same time, it must be pointed out that other Upper Republican sites in the Loup drainage are marked by shallow surface depressions, indicating either that less soil was deposited over them or else that the houses and caches were dug through the covering material and are thus later. The villages occupied by the Pawnee on the lower Loup and Platte Rivers seem never to have been thus buried, and the old lodge circles were always clearly visible before their obliteration by the plow. Still farther east, along the Missouri, the Nebraska culture sites which are believed to have been occupied synchronously with some of the Upper Republican villages, charac-

teristically show deep, well-marked house pits where they are not under cultivation.

It has already been noted that Woodland sherds and stone artifacts have been found in western Kansas and in Nebraska in similar buried humus strata. Wherever Upper Republican and Woodland remains occur on the same location, the latter are always at the bottom. For example, near Healy, in Lane County, Kans., Upper Republican village remains (pl. 5, fig. 2, stratum A) occur just below the wind-eroded surface of several small terraces. Below, and separated by a few inches to nearly 2 feet of sterile gray soil (pl. 5, fig. 2, stratum D), is a dark-gray stratum yielding hearths and Woodland artifacts (pl. 5, fig. 2, stratum B).[†] The number of known similar occurrences in the Republican, Loup, and other more northerly river valleys is increasing.

Insofar as they relate to prehistoric man, the dust deposits of the Republican Valley and adjacent areas, as just described, have not been closely studied by physiographers or geologists. It should be noted that the repeated dust storms of the past decade accompanying droughts which wiped out the corn crop in many localities have not produced comparable formations in the Republican and Loup Valleys, though elsewhere deep drifts and dunes have been formed where fences, hedges, and other obstructions tend to break the wind. It is not certain that these deposits result from a single short, intense drought such as that evidenced at Lynch. It has been suggested to me that they can more reasonably be interpreted as a gradual accumulation over a period of many years. At the same time, the fact that the dust covers a dark humus stratum which often contains archeological remains would seem to indicate that a period of fairly rapid deposition followed a more humid interval which lasted long enough to produce a vegetative cover and to become the home of sedentary farming peoples. In other words, I see no reason why the different strata cannot be viewed as evidence of climatic fluctuations analogous to those inferred from the findings at Signal Butte.

Carefully controlled studies in the past decade have made it possible to arrange the major archeological horizons of the central Great Plains in sequential order (see summary in Wedel, 1940b). Where evidences of severe drought, or of prolonged periods of subnormal precipitation and consequent increased soil deposition, are definitely linked with these horizons it may be possible to determine the ap-

[†] What is possibly a third occupation zone here is indicated as stratum C in plate 5, figure 2; from it came only broken animal bones and fire-cracked stones, hence the horizon remains unidentified.

proximate time involved. At Signal Butte, as already indicated, the dry periods have been tentatively assigned an antiquity of several millenia. At Lynch, on the other hand, the archeological evidence points toward a very much more recent drought—one that might have occurred as late as the sixteenth or seventeenth century.⁸ The dust blanket on the Upper Republican sites in southern Nebraska must have begun to accumulate at least 400 years ago, since there is evidence that the Pawnee were living in large villages in eastern Nebraska in Coronado's time (1541) but none whatever that contemporary horticultural earth-lodge-using peoples lived in the western plains.

The estimates of age here given are inferential, and rest on archeological and historical data. At present they cannot be checked by precise methods such as dendrochronology offers in the Southwest. However, as already indicated, red cedar (*Juniperus virginiana*) is widely distributed throughout the High Plains, and there is good evidence that western yellow pine grew scatteringly eastward to the 99th meridian as late as the nineteenth century. Moreover, it should be borne in mind that charred pine and juniper have been found in

⁸ M. E. Kirby, of the U. S. Engineers office at Omaha, Nebr., has called my attention to relevant data by Upham (1895, p. 594) concerning fluctuations in the surface levels of certain glacial lakes in North Dakota. Devils Lake and nearby Stump Lake in the northeastern part of the State present highly irregular outlines and are believed to occupy the valley of a preglacial river which has been elsewhere buried with drift. In historic times Devils Lake reached its highest level about 1830. At about the same time occurred record high-water levels in Red River and in the Great Lakes. Thus, 1830 would appear to represent the high stage in a period of heavy precipitation. The shore line of Devils Lake at that time is indicated by a line of heavy timber. Between this and the recent shore line Upham noted a stand of smaller trees which in 1889 showed a maximum of 57 annual growth rings. During the 1830 high stage the waters flowed into Stump Lake a few miles to the southeast, but the latter never attained the same level as Devils Lake owing to evaporation. The early postglacial outlet of Stump Lake into the Sheyenne River was dry during the 1830 high water, as shown by a stand of large timber growing across the channel. This timber corresponds to that marking the 1830 water line in Devils Lake.

At present, in the bed of Stump Lake, North and South Washington Lakes, and Lake Coe, all situated near Devils Lake, there are old stumps of trees which grew when the lakes were dry some time before the 1830 rise. Many of these have been uprooted and used for fuel. Some of the stumps on the lake bed showed as many as 115 annual rings, indicating well over a century of deficient rainfall. It is not known just when the protracted period of desiccation here indicated came to an end, but it must have been long before 1830, since many years of heavy rainfall would be required to refill the lakes. Upham suggests that the drought represented here may have coincided with the arid conditions in the Great Basin which are supposed to have dried up Pyramid, Winnemucca, and other lakes in Nevada about 300 years ago.

Upper Republican pit houses (Wedel, 1935, p. 170); that the former distribution of pine and the present occurrence of juniper overlap the known range of the prehistoric Upper Republican horizon; and that much of the area of overlap in the western plains has a low rainfall which is apparently directly reflected in tree growth. Working on wood specimens from historic log structures and from old stumps in gully fills in Lincoln County, Nebr., Weakly (1940) reports a continuous tree-ring sequence reaching back to about A. D. 1480. The buried material is said to have given "very readable ring sequences," but absolute dates have not yet been assigned. All this raises the hope that continued research, combining dendrochronology with archeology, will soon produce exact tree-ring datings for some of the late prehistoric and protohistoric culture horizons in the western plains, and also establish the time of some of the associated drought evidences in the same region.

In another paper (Wedel, 1940b, p. 329), I have suggested the possibility that abandonment of the western plains by sedentary horticultural peoples in late prehistoric times may have been due in part to inability to cope with drought conditions. This view has been questioned by ecologists with whom I have discussed the point. Their contention is that the small gardens of the Indians, unlike the present-day farms, would have been situated only in sheltered bottom-land pockets where there was maximum protection against hot winds and where natural drainage conditions would have provided subirrigation. Moreover, the practice of storing one to several years' supply of corn against the contingency of crop failure would have carried them through droughts such as those of the historic period. In this connection a perusal of the reports of the various Indian agents in the Kansas and Nebraska territories is instructive.

The effects of the droughts of 1860, 1870, and 1893-96, in terms of large-scale populational movements out of the plains by white settlers, have been frequently recounted.⁹ Their effects on the native and transplanted Indian populations, however, seem to have gotten little attention. According to the report of the Commissioner of Indian Affairs for 1860, the Pawnee (pp. 94-95) "had about 800 acres of corn, pumpkins, beans, etc.; but owing to the extreme drought in this section of the country, and improvident farming, their crop is very light." Among the Oto and Missouri (*ibid.*, pp. 96, 97) a highly favorable spring was followed by three rainless months, with "a constant burning sun and scorching wind, the result of which is the

⁹ Summarized in Clements and Chaney, 1937, p. 41.

entire loss of their crops. . . ." Even the grass was burned up, so that neither the Indians nor the agency were able to lay up their usual reserve of hay for the winter. Along the Nemaha, the Sac and Fox (*ibid.*, p. 99) fared a little better, with the prospect of half a corn crop and considerable hay. The Kickapoo (*ibid.*, p. 101) in northeastern Kansas who had just been presented with oxen, plows, and other farm machinery, were giving up their farms consisting of "8 to 10 acres of soft turfless ground among the girdled trees skirting the narrow borders of the creeks" and were venturing out into the prairies. For them, 1860 brought the worst drought of their 30-year sojourn west of the Missouri, and a complete crop failure. The Pottawotamie (*ibid.*, p. 41), the Sac, Fox, and Ottawa (*ibid.*, p. 111), the Kansa (*ibid.*, p. 113) together with the Kaskaskia, Peoria, and other tribes on the Osage River in eastern Kansas were equally hard hit. Total or partial crop failures are also reported for the Choctaw, Cherokee, Chickasaw, Quapaw, and Wichita (*ibid.*, pp. 114-123) far to the south in the Indian Territory. According to the agents, the alternatives confronting the natives everywhere throughout this vast region were starvation, government aid, or recourse to the plundering of such of their white neighbors as were receiving relief from the government or from friends in the east.

A decade later, in 1870, drought struck again, but this time it affected the Indians over a much smaller area. At the Whetstone Agency, Dakota Territory, the crops were destroyed by a 2-month drought in June and July. At the Santee Agency, in northeastern Nebraska, 370 acres of corn were a total loss. The agent for the Ponca wrote that "Had it not been for the very long and severe drought, they would have realized a yield of at least 14,000 bushels. On the first of July their crops looked well, and I was of the opinion that the bottom lands would not be affected by the drought; on the contrary, the whole was an entire failure. . . . This tribe is now bordering on starvation." In southern Nebraska, of the Oto it is said that "On the bottom lands a few will probably succeed in harvesting light crops of corn; but I fear those . . . on the upland . . . will experience an almost entire failure of their crops. . . ." Throughout northeastern Kansas the tribes generally seem to have fared very well. Weather records show that Leavenworth, Kans., enjoyed an excess precipitation of nearly 25 percent in 1870, which suggests that the reservation Indians hereabouts may have been out of the main drought area.²⁰

²⁰ References to insect pests are rare in these reports. In 1870, however, the agent for the Yancton Sioux suggested (p. 212) the advisability of removing

Prior to 1860, data on drought conditions in the central Great Plains are scarce. We may note, however, that in 1848 the Council Bluffs Agency reported that "The government has purchased the past season for the Pawnees between 1700 and 1800 bushels of corn, to keep them from suffering. . . . They are still in a miserable condition; their crops this season have almost been an entire failure, owing to the drought. Their corn in the Platte bottoms was literally burned up; . . . they will suffer, unless they make an unusual good hunt this winter."

The distressing conditions set forth in these reports are a significant commentary on the reactions of Plains Indian farming communities to drought. It can be objected that at this late date the old cultural patterns of such tribes as the Pawnee, Omaha, Oto, and Ponca were swiftly falling apart. Their horticultural economy was only a part-time interest, and probably but a dim reflection of what it evidently had been a hundred or two hundred years before. Moreover, tribes like the Kickapoo, Sac, Fox, Ottawa, and others, were originally residents of more easterly drought-free areas who had been moved onto reservations west of the Missouri so recently that there was insufficient time or incentive to make the necessary adjustments to a changed environment. All this is true. But it is also true that the area inhabited at this time represents the best corn-growing section in the central Great Plains, climatically and otherwise. It must be remembered, too, that there was no contemporary Indian agriculture beyond the 99th meridian in the High Plains, and the above observations contain about the only extant data concerning such activity under pronounced drought conditions beyond the Missouri.

The recorded droughts of the nineteenth century, despite their occasionally calamitous effects, were relatively short-lived affairs. Most of them meant only a year or two of subnormal precipitation; in no case has there been, since the coming of white settlers, as much as a decade of continuous drought and unbroken crop failure. For this reason, it is impossible to say how long or how intense a period of drought would be needed to kill off the sod cover to the point where large-scale soil movements could take place. Clements (1938, p. 202) states that "even a thin cover of vegetation controls the wind so

these Indians from "a climate where crops are so uncertain, owing to the scarcity of rain and the ravages of the grasshopper. . . ." He says further that ". . . in five years of the last ten the crops were totally destroyed by the drought and grasshopper, and in one year of the ten there was about half a crop . . ."

effectively that soil-drift and deposition during the past must have been limited to bare areas such as ocean-strands and river-banks. During the historical period, dust storms have come only from soils exposed by man in the course of settlement." The second statement, at least, may need revision, since terrific sand and dust storms apparently rivaling in intensity those of recent years were experienced by McCoy and his surveying party in northern Kansas 200 miles west of the Missouri as early as 1830 (McCoy, 1840, pp. 408-409). The material which overlies Upper Republican sites can hardly have been due to man's work, since it unquestionably antedates the era of modern agriculture and could never have been an aftermath of the small-scale horticulture practiced by the people whose remains it covers.

In his discussion of the Lynch site, Van Royen (1937, pp. 645, 648) expresses doubt that 20 to 25 years of drought would have been sufficient to destroy the local sod cover and inaugurate wind erosion leading to the topographic changes there noted. On the other hand, many farmers in the western plains maintain that 5 years may be enough to kill the grass and start serious soil movements, even where no overgrazing has taken place. On this point, agricultural experts with whom I have talked corroborate the observations of the farmers. In light of these latter statements it would be interesting to know just how long the droughts suggested by the archeological record may have lasted. A possible clue lies in the tree-ring studies already mentioned.

Weakly (1940) has called attention to the presence of aeolian deposits in canyons in the vicinity of North Platte, Nebr., beneath which red-cedar stumps are buried. Annual rings on these stumps "indicate a period of over 30 years with deficient moisture. Apparently this drought period contributed very largely to the death of these trees." Presumably, the fill overlying these stumps is a result of wind action on the surrounding uplands after these had been partially or largely denuded of their sod cover. The drought conditions manifested here have not yet been dated. They have significant implications, however, for they suggest that prolonged droughts comparable to those held responsible for extensive ethnic disturbances in the Southwest in 1276-1299, and again in 1573-1593 (Douglass, 1935, p. 48), might well have occurred in the Great Plains, though not necessarily concurrent.

In addition to this as yet undated major drought, Weakly believes his tree-ring data prove the occurrence of a number of shorter periods of deficient rainfall. Some of these "would have been very

severe even on the present population of this section and . . . would have been a major catastrophe to a population of aboriginal farmers. Several of the drouths were of sufficient severity to very largely depopulate the plains even now. . . ." (Letter of March 7, 1941.) In this same letter, Weakly informs me that the major dated drought periods previous to 1700 are as follows:²¹ 1439-54 (15 years), 1459-68 (9 years), 1539-64 (26 years), 1587-1605 (except for 1594-96). I am inclined to suspect that if Weakly's chronology has been extended beyond question to the early part of the fifteenth century, he may be on the threshold of an exact dating for some of the Upper Republican village sites in western Nebraska.

We have already indicated that the western portions of the Upper Republican habitat have a low irregular rainfall which borders on the minimum required for successful farming. It can be assumed that these peoples farmed intensively and that they were far-sighted enough to lay by seed corn and food against a year or two of crop shortage. At the same time it may be doubted that their harvests were ever on the scale of those normally enjoyed by the later Pawnee and other horticultural peoples farther east. In light of the difficulties experienced by Indians in the eastern plains during the brief droughts of 1860 and 1870, I am led to believe that when hot, searing winds and droughty summers visited the aboriginal farmers throughout the western Great Plains, crop failures and some measure of destitution were their lot in prehistoric days as well. Dry years may also have given rise to insect plagues, as they do today, further complicating the native economy. The delicate balance between annual precipitation and crop yield has been noted elsewhere in this paper. If drought conditions recurred for several successive years, or if there was a drop of several inches in the average annual precipitation over a period of 10 or 20 years or more, perhaps with springs and watercourses drying up, there would have been no choice for the natives other than that of abandoning their villages and removing eastward to better-watered and more dependable regions. A sedentary mode of life such as that indicated for the Upper Republican peoples, involving relatively permanent earth-lodge villages, would have been impossible when climatic or other factors prevented the cultivation of maize. All this leads me to suggest again that the early horticultural peoples of the Upper Republican communities may have been forced out of their habitat in western Kansas and Nebraska, probably toward the east, in large part by a long-continued

²¹ A manuscript detailing the results of Mr. Weakly's tree-ring studies is awaiting publication by the U. S. Department of Agriculture.

period of subnormal rainfall, the outstanding physiographic aftermath of which is seen in the dust which today covers many of their ancient living sites.²²

²² The relation between the prehistoric Upper Republican peoples and the historic Pawnee is still a puzzle. There is nothing in Pawnee traditions to suggest that this group was a late arrival west of the Missouri, and it is generally believed that they were firmly established in or very near their historic locale at the time of Coronado's march into the plains. Strong (1935, p. 277) has suggested that the Pawnee may have been the lineal descendants of the Upper Republican peoples. This is based on a number of resemblances involving basic house types, pottery, and the general semisedentary horticultural mode of life. Persistent search has so far failed to produce a single site in Nebraska which could be regarded as intermediate between the Upper Republican horizon and the earliest protohistoric village remains attributable to the Pawnee. On the contrary, the small, open, undefended villages, prevailingly rectangular pit houses, cord-roughened pottery, and communal ossuary burials of the Upper Republican peoples are consistently in contrast to the large, defensively situated, fortified towns, invariably circular earth lodges, corrugated paddle pottery, and individual flesh interments of the Pawnee. The much sought "clear unbroken line of ceramic and other development" foreseen by Strong is not yet at hand, nor can we say how long the gap in the proposed sequence is. The data on physical anthropology, which may well be crucial in this connection, are either nonexistent or unpublished.

Recent excavations (Wedel, 1941) in Rice County, Kans., have shown that small but consistent amounts of Upper Republican-like cord-roughened pottery occur here, along with puebloan sherds of ca. 1525-1650, at village sites tentatively ascribed to the Wichita. There is also some evidence of ossuary burial. Strong (1940, p. 382) has recently proposed that the Arzberger site near Pierre, S. Dak., represents "a late prehistoric horizon, basically Upper Republican, but in process of development into the more specialized and later protohistoric Pawnee (to the south) and Arikara (in the north)." As I have indicated in this paper, there is also a strong possibility that a late phase of the Upper Republican culture survived into virtually protohistoric times in northeastern Nebraska, as shown by the pottery remains at Lynch. In other words, traits which may be regarded as of Upper Republican derivation appear to have survived later in the eastern plains and in South Dakota and Kansas than in the Upper Republican-Pawnee region in Nebraska. One wonders, therefore, whether the postulated development from a prehistoric into a historic entity, or entities, may not have taken place outside the Nebraska area, with the Pawnee on the Loup and Platte Rivers representing a backwash. According to their traditions, the Pawnee entered Nebraska from the east and south rather than from the north, which might explain certain ceramic (as for example, the cloistered rims) and other elements in their material culture which have an easterly rather than Upper Republican flavor. This is admittedly a thorny problem and one which cannot be certainly answered with the information now at hand. As a working hypothesis, however, it may be well to bear in mind the possibility that the threads running from the Upper Republican to the Pawnee, if they exist, may have to be traced out of Nebraska and then back at a somewhat later period, which, in any case, should precede 1541.

As has been pointed out elsewhere, the occurrence of dust-covered humus strata containing human debris is more frequent in the central Great Plains than has commonly been supposed. Moreover, to the best of my knowledge this does not involve the remains of such historic tribes as the Pawnee and their Siouan contemporaries whose villages and campsites seem always to have been situated on the present ground surface. If the similarity between Signal Butte and other later stratified or "buried" sites can be taken as evidence of like climatic fluctuations, then it would appear that the record of man's activities in the western plains is linked with the periodic development of stable humus zones between which there are dry-weather dust deposits. Thus, in the archeological record we have Signal Butte I and Signal Butte II, each succeeded by periods of undetermined duration during which dust was being laid down. Later came pottery-making groups: First the Woodland, then the patently horticultural Upper Republican, each followed by periods of increased deposition. There is at present no way of determining accurately the length of time required for the development of these now-buried humus zones on which prehistoric farming peoples once carried on their everyday activities over much of the central and western Great Plains. It seems to me, however, that these intervals must have been of some length since the human occupancy spread westward about as far as climatic factors would permit corn growing. In any event, if the repeated interludes of deposition were indeed the aftermath of decreasing rainfall and increasing wind activity, as contrasted to the more humid periods which produced the humus layers, we may visualize the farming Indians as having ventured far out into the Great Plains during favorable times only to withdraw when droughts set in.

CONCLUSION

It need not be assumed from the findings of archeology that any major climatic change or permanent desiccation has taken place in the central Great Plains within the span of time represented by the various aboriginal pottery-making groups formerly resident there—or, as a guess, within the past 8 or 10 centuries. In all likelihood, however, shorter or longer periods of deficient rainfall have occurred repeatedly in prehistoric as in historic times. Some of these periods were probably of sufficient duration or intensity to depopulate the western plains for a time. The occupation of the region by migratory hunters since at least 1541 may well be due to the accidents of history as much as to any unfavorable climatic trends. That

is to say, it is conceivable that had the hunters first seen by Coronado's party not received horses and firearms from the whites, maize-growing peoples might again have extended their occupation westward beyond the 99th meridian. In view of the still sketchy nature of our information on plains prehistory, it is impossible at this time to evaluate fully the respective importance of environment and of historical accident on the alignment of native economies in the region. Nevertheless, it begins to look as though alternate settlement and abandonment was true of primitive man's occupation of the western plains just as it has characterized the subsequent white man's tenure where large-scale government aid was not forthcoming during periods of adverse climatic conditions.

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TYPICAL SCENE IN A PLAINS INDIAN HUNTING CAMP OF THE
NINETEENTH CENTURY

Photograph by S J Mottow probably made in the upper
Missouri Valley about 1870



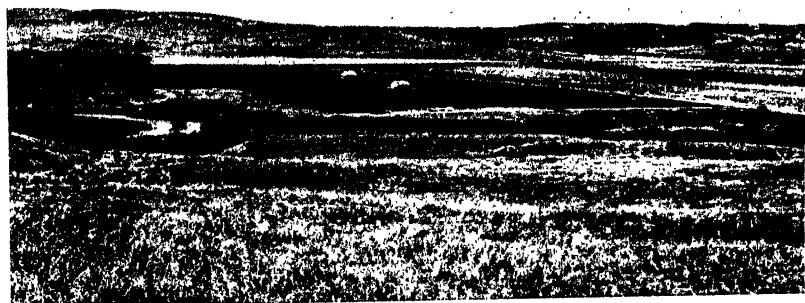
EARTH-LODGE VILLAGE OF THE PAWNEE A TYPICAL SEMIHORTICULTURAL TRIBE OF THE EASTERN PLAINS ON THE LOUP RIVER NEAR GENOA NEBR

Photograph by W H Jackson 1871



1. BEAVER CREEK VALLEY IN SCOTT COUNTY, KANS.

The even skyline, scattered trees, and short grass are characteristic of the High Plains. A Pueblo ruin and other protohistoric Indian remains lie at the center of the view.



2. VIEW IN THE VALLEY OF STINKING WATER CREEK, CHASE COUNTY, NEBR.

The remains of a protohistoric village of hunting and farming Indians occupy the flat immediately across the stream.



1. VIEW IN THE REPUBLICAN VALLEY, FRANKLIN COUNTY, NEBR.

The Dooley site, type station for the prehistoric Upper Republican culture, lies on Lost Creek, just to the left of the loess bluffs.

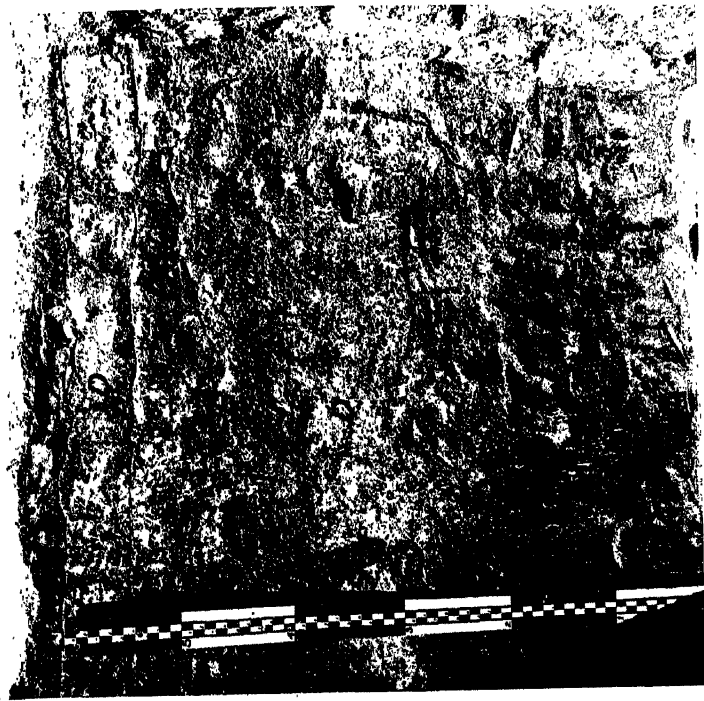


2. STRATIFIED SITE ON DAVIS CREEK, NEAR COTESFIELD, NEBR.

Twelve-inch dust mantle (A) overlying dark gray humus stratum (B) containing potsherds and other remains of Upper Republican type.



1. DEEPLY BURIED HEARTHES AT WALKER GILMORE SITE (WOODLAND), CASS COUNTY, NEBR.



2. STRATIFIED SITE ON SALT CREEK, LANE COUNTY, KANS.

See page 19 for explanation.

SMITHSONIAN MISCELLANEOUS COLLECTIONS
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BEETLES OF THE GENUS *HYPERASPIS* INHABITING THE UNITED STATES

(WITH 6 PLATES)

BY
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BETTER OF THE GENUS HYPERASPIS INHABITING THE UNITED STATES¹

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(WITH 6 PLATES)

Hyperaspis is one of the largest and least-known genera of the family of ladybird beetles (Coccinellidae). Its representatives are economically important as predators on scales and other insect pests. They can be bred in the laboratory and may prove to be favorable material for experimental work. The center of dispersal of *Hyperaspis* is in Central and South America. The fauna of the United States is relatively rich, especially in the South and Southwest, but only a few stray species have found their way into Canada and the Old World. *Hyperaspis* appears to be a young genus in which the processes of species differentiation are in progress.

Most of the available information on the North American *Hyperaspis* must be credited to Thomas L. Casey, who is the author of more than half of the described species. Casey was in the habit of treating as species even insignificant structural and color variants. That Casey recognized the provisional nature of many of his "species" is shown by the following statement in his Revision of the American Coccinellidae (1899): "Although it is possible that many of the forms . . . may prove to be more properly subspecies of a few type forms, which could be determined by future collecting and careful investigation, they are at least apparently worthy of distinctive names for future reference, and that is all that can be positively affirmed at present. . . ." The present paper attempts a critical evaluation of the relationships between various representatives of the genus *Hyperaspis* on the basis of more abundant material than that available to previous workers. The results arrived at are still largely tentative, especially since the fauna of *Hyperaspis* of Mexico and Central America could not be examined. This is important because many

¹ This is the fourth contribution to be published by the Smithsonian Institution under the Thomas Lincoln Casey Fund.

species of *Hyperaspis* reach their northern limits near the southern boundary of the United States, and the main parts of their distributions, as well as those of their closest relatives, are outside the territory the fauna of which has been studied.

The study is based primarily on the collections of the United States National Museum (later referred to as NMC), lent to the writer through the courtesy of Dr. E. A. Chapin. In addition, the collections of Thomas L. Casey (abbreviated below as CC) containing his types, of F. T. Scott (SC), the California Academy of Sciences (CASC, including those of Dr. E. P. Van Dyke and E. P. Van Duzee), P. H. Timberlake, Charles W. Leng, The Citrus Experiment Station of the University of California, San Diego Museum, University of Idaho, University of Minnesota, Illinois State Natural History Survey, and Oregon State College have been examined. To the owners and guardians of these collections the writer wishes to express his sincere appreciation of their courtesy; an especial acknowledgment must be made of the help and advice received from Dr. E. A. Chapin.

Since the distinguishing of species and races of *Hyperaspis* is still based to a large extent on their color patterns, drawings of most of the species are given in plates 1-3. It is believed that these drawings, despite their crudity, will be of much service to those who will use this paper in their work of determining *Hyperaspis*, and certainly even such drawings save many words in the description of the respective species. In the list of the localities in which each species is known to occur only those localities are included from which some specimens have been personally examined by the writer; a few exceptions from this rule are explicitly stated to be such. The names of the collectors and of the museums in which the specimens are found are indicated only for rare species and for particularly interesting records.

Genus *HYPERASPIS* Redtenbacher (1843)

Medium-sized to small representatives of Coccinellidae. Body from elongate-oval to rounded-oval, from moderately convex to subhemispherical, upper surface always glabrous, the abdomen pubescent in a few species. Head not dilated laterally, base of the antennae exposed, eyes without emargination, rather finely faceted, frequently greenish in color. Antennae (pl. 6, fig. 167) short, 11-jointed (the two last joints almost fused), the apical portion fusiform. Mandibles (pl. 6, fig. 169) bifurcate at the apex, with a bicuspidate tooth at base, and a finely ciliate membrane internally. Maxillae (pl. 6, fig. 170)

small but with a strongly developed maxillary palpus; the last joint of the palpus securiform, but not more than twice as large as the two preceding joints. Mentum obcordiform, labium membranaceous at the apex, covered with very minute ciliae, apparently of a sensory nature; labial palpi small, two-jointed. Pronotum and the elytra tightly fitted to each other, scutellum large, elytral epipleurae narrow, with distinct foveae for the reception of the knees. Prosternum with two carinae more or less widely separated at base, converging cephalad, fused together before reaching the anterior margin of the segment, and usually continued forward as a single line. Abdomen with six clearly visible sternites, the first of which carries the femoral (metacoxal) lines, the exact shape of which varies from species to species. Legs short, tibiae slender, not spinose, anterior ones with an external plate delimited by an oblique suture, tarsal claws with a tooth at base (pl. 6, fig. 168) which is rudimentary in some species.

Coloration predominantly black (in the following text the body parts, the color of which is not stated, are assumed to be black, except that species having light-colored lateral portions of the pronotum have also light pronotal epipleurae, and those having light humeral or marginal spots or marginal vittae on the elytra have also correspondingly colored elytral epipleurae). Coloration of the head and the pronotum is usually sexually dimorphic, being lighter in the males than in the females. With very few exceptions, all the tremendous variety of the elytral patterns of the North American *Hyperaspis* (pls. 1-3) may easily be derived from a single type, or basic, pattern, consisting of five light spots on the black background of each elytron (pl. 1, fig. 31). Among these spots, the one lying on or near the external margin posteriorly from the humeral angle of the elytron is termed the humeral spot; that lying outward and posteriorly from the scutellum is the basal spot; that located on or near the external margin near the middle of the length of the latter is the marginal spot; the discal spot occupies the middle of the elytron; the apical spot lies in front and outward from the apex. These spots may disappear or fuse in various combinations, intraspecific variations being common. The position of the spots relative to each other and to the fixed points of the elytron (suture, base, apex, scutellum, etc.), and to a certain extent their relative sizes, are, on the contrary, very constant within a species but greatly variable from one species to the next; certain correlations between the position of the spots and the shape of the elytron and the body may be discerned.

Both the dorsal and the ventral surfaces of the body are covered with punctures, the density and the strength of which vary from

species to species. In general, the punctures on the head are finer than those on the pronotum, and those on the pronotum are finer than those on the elytra. On the ventral surface the punctures tend to be especially dense and strong on the sides of the metasternum and mesosternum and on the middle part of the first abdominal sternite; the space enclosed by the femoral lines is frequently almost devoid of punctures. The interstices between the punctures may be polished or alutaceous.

Male reproductive organs (pl. 4, fig. 104) consist of six-lobed testes (T), a short vas deferens (VD) enlarged to form the seminal vesicles (SV), two pairs of accessory glands (AG) one of which is much shorter than the other, a long ejaculatory duct (DE), an extrusible siphon (aedeagus, sometimes misnamed penis, S), basal plates (BP) to which the true penis is attached (median lobe, P), paired paramera (lateral lobes, PA) carrying a tuft of bristles distally and sensory pores proximally, and trapes (TR, tegmental strut). The penis is always asymmetrical, and its shape varies greatly from species to species; paramera and basal plates are also variable, while the siphon and trapes are rather uniform.

Female reproductive organs (pl. 4, fig. 106) consist of ovaries (OV) with 10 to 12 egg-strings, rather short oviducts (OD), a conical bursa copulatrix (BC), a complex spermatheca (RS) with an accessory gland (GR), and the chitinized parts of the ninth sclerite (9ST) and tenth tergite (10T) densely covered with short but stubby hair. The spermatheca (pl. 6, figs. 157, 158, 162-166) is divided into a thimblelike basal portion and a more or less retort-shaped distal capsule united with the basal portion by means of a very slender tubular connecting duct. The basal portion has a chitinized appendix the size of which varies greatly from species to species.

I. LEVRATI GROUP

This group includes a large number of species living in Central and South America, but only two are known to occur in the United States. It is a part of the Mulsant's genus *Cleothera*, which all the more recent authors consider not to be a natural unit, and therefore treat as a synonym of *Hyperaspis*. The elytral pattern consists of a marginal vitta resulting from a confluence of the humeral and marginal spots, and of basal, discal, and apical spots. Male genitalia have a very short, very asymmetrical penis, large basal plates, and short and broad paramera.

HYPERASPIS LEVRATI (Mulsant)

PLATE 2, FIGURE 62

Cleothera levrati MULSANT, 1850, p. 613.

Hyperaspis levrati GORHAM, 1894, p. 192.—SCHAEFFER, 1905, p. 145.

Brachyacantha metator CASEY, 1908, p. 413.—LENG, 1911, p. 8.

Rounded oval, strongly convex. Head whitish yellow in males, black in females. Pronotum distinctly longer at the middle than on the sides, in males with pale yellow stripes on the anterior and lateral margins, the lateral stripes being wider than long, in females with lateral stripes only which are longer than wide. Elytral spots pale yellow; the marginal vitta extending from the base to two-thirds of the length of the margin, its posterior part (corresponding to the marginal spot) much wider than the anterior one, basal and discal spots rounded, the former smaller than the latter, apical spot transversely oval. Punctulation rather dense and strong. Mouth parts and legs yellow, femora brown in females, sides of the abdomen usually piceous. Prosternal carinae fused in front of the coxae; femoral lines almost touching the posterior margin and running subparallel to it, their outer parts not reaching the sides of the segment. Penis (pl. 4, fig. 111) much shorter than the paramera, the latter broad, spoon-shaped, densely covered with hair distally and with sensory pores proximally. Basal portion of the spermatheca large, with a small appendix, the capsule spherical, the connecting duct rather short and broad.

Length of the body, 2.2-2.6 mm.; width, 1.7-2.0 mm.

Geographic distribution.—Localities as follows:

Wyoming: Bosler (P. C. Ting, NMC).

Colorado: Canon City (NMC), Cortez (Th. Dobzhansky).

Texas: Del Rio (type of *Brachyacantha metator*, CC).

Arizona: Cochise County, Palmerly, Santa Rita Mountains, Huachuca, Tucson, Winslow.

Mexico: (exact locality label unreadable, CC).

Remarks.—Casey considered this species to belong to the genus *Brachyacantha*, but later has himself placed it in *Hyperaspis*, without apparently realizing its identity with *levrati* (Mulsant). The specimens from Wyoming and Colorado are larger and have relatively smaller spots than those from more southern States. This northern race may possibly deserve a subspecific name, but I prefer to await further material before deciding this issue.

HYPERASPIS REVOCANS REVOCANS Casey

PLATE 2, FIGURE 63

Hyperaspis revocans CASEY, 1908, p. 410

Broadly oval, somewhat obtusely rounded behind, convex. Head and mouth parts yellow in both sexes; pronotum yellow with a large black semicircular spot on the base in males, black with yellow lateral and anterior margins in females. The elytral pattern variable: marginal vitta as in *levrati* but equally wide anteriorly and posteriorly and somewhat narrower in the middle; apical spot very large, sometimes confluent with the marginal vitta; basal and discal spots much smaller than the rest but broadly confluent with each other, forming an oblique vitta extending from the vicinity of the scutellum to past the middle of the length of the elytron; in some specimens this vitta is confluent with the marginal one and with the apical spot, giving yellow elytra with a black vitta on the suture expanded at one-third and two-thirds of the length and a wedge-shaped black vitta extending from the base to two-thirds of the length and somewhat more remote from the suture than from the margin. Punctulation dense but rather fine, interstices polished. Mouth parts, legs, and abdomen piceous yellow, femora infusate in females, in some specimens the entire under side piceous. Prosternal carinae fused not far from the anterior margin, femoral lines more evenly arcuate than in *levrati*. Penis (pl. 4, fig. 115) shaped like a shark's tail fin, only slightly shorter than the paramera, the latter very short, basal plates relatively very large. Female genitalia unknown.

Length of the body, 1.5-1.9 mm.; width, 1.2-1.5 mm.

Geographic distribution.—Localities as follows:

Utah: St. George (type, CC, topotypes in C. W. Leng's collection).

Arizona: Phoenix (SC), Hot Springs (NMC), Yuma (NMC).

California: San Diego County, La Puerta (CASC).

Remarks.—This species is related to *levrati* Mulsant, but the differences between the two amply justify their specific distinction; although they have never been found in the same locality, their ranges probably overlap.

HYPERASPIS REVOCANS OCCIDENTALIS, new subspecies

PLATE 1, FIGURE 37

Somewhat less broadly oval than the typical *revocans*, punctulations of the pronotum and the elytra finer, interstices strongly polished. Elytra with a yellow marginal vitta which is narrower than in the type form, a rather large apical spot, a small rounded or comma-

shaped basal spot, and no trace of a discal one. Genitalia of the male identical with those of the typical form.

Length of the body, 1.8-2.2 mm.; width, 1.4-1.6 mm.

Type.—In collection of F. T. Scott.

Paratype.—U.S.N.M. No. 54198.

Geographic distribution.—Locality as follows:

California: Kettleman City, 3 ♂♂ and 2 ♀♀ including the type (on *Artiplex* infested by a species of *Orthesia*, F. T. Scott, SC).

II. OCTONOTATA GROUP

Only three species of this group occur in the United States, all their relatives being native to Central and South America. The elytral pattern consists of a humeral, marginal, apical, and discal spots, the first two sometimes fused to form a marginal vitta. The discal spot located in front of the middle of the length of the elytron. Penis knife-shaped, about as long as the paramera. The capsule of the spermatheca retortlike, gradually passing into the connecting duct.

HYPERASPIS OCTONOTATA Casey

PLATE 2, FIGURE 53

Hyperaspis octonotata CASEY, 1899, p. 121.

Very broadly oval, somewhat obtusely rounded behind, strongly convex. In males the head, large subquadrate spots on the lateral, and a stripe on the anterior margin of the pronotum yellow, in females head black, pronotum with yellow spots laterally but without a stripe on the anterior margin. On the elytra, the humeral spot extending from the base to about one-fifth of the length, longer than wide, usually parallel-sided, abruptly terminated posteriorly; the marginal spot semicircular; the apical one rounded or transversely oval; the discal one rather small, somewhat oblique, oval or comma-shaped. Pronotum densely and rather finely, elytra less densely but only a little more strongly punctured, abdominal segments very densely and strongly so. Mouth parts and femora dark brown, tibiae and tarsi yellow, sides of the abdomen brown. Prosternal carinae short, fused only slightly in front of the coxae, femoral lines angular, touching the posterior margin of the segment at one point only. Penis (pl. 4, fig. 122) knife-shaped, one side nearly straight, the other straight basally but rounded toward the apex; paramerae long and slender, finger-shaped, basal plates rather short. The basal portion of the spermatheca about twice as long as wide, the appendix very short.

Length of the body, usually 2.4-2.9 mm.; width, 2.0-2.4 mm.; exceptional individuals considerably smaller.

Geographic distribution.—Localities as follows:

Texas: Brownsville, Esperanza Ranch, Round Rock, Del Rio, Sanderson, Davis Mountains.

Colorado: Canon City (NMC).

Utah: St. George (C. W. Leng collection).

Arizona: Phoenix, Wilcox, Graham County (on *Toumeyella mirabilis*), Benson, Cochise County, Palmerly, Tubac, Chiricahua Mountains, Oracle, Tucson (on *Toumeyella mirabilis*), Santa Rita Mountains, Huachuca Mountains, Miller Canyon.

California: San Francisco (SC), Santa Maria (on *Physokermes insignicola*), Santa Barbara (on *Physokermes insignicola*), Tulare County (a series of more than 100 individuals, on *Cocculus pseudomagnoliarum*, SC), Sequoia National Park (SC), Kern County.

Mexico: Durango (CC), Chihuahua (on *Toumeyella mirabilis*, NMC), Ontagota Yaki Valley (on tree cotton, NMC).

Remarks.—Individuals from the coastal zone of California tend to have a somewhat larger size and to have the yellow coloration of the elytral spots replaced by a red. For the time being I see no need of giving this race a separate name.

HYPERASPIS BENSONICA BENSONICA Casey

PLATE I, FIGURE 3

Hyperaspis bensonica CASEY, 1908, p. 418.

Broadly oval, strongly convex, pronotum short and broad, elytra obtusely rounded behind. In females head and pronotum black, in males head yellow with a transverse black fascia on the vertex usually covered by the margin of the pronotum, pronotum with the lateral and anterior margins narrowly yellow. Elytra with a yellow marginal vitta extending from the base to two-thirds of the length of the margin, strongly sinuate internally, the discal spot rounded or longitudinally oval, the apical larger than the discal one, transversely oval, in some specimens showing a tendency toward confluence with the marginal vitta. Punctulation of the pronotum dense and rather strong, that of the elytra both sparser and finer (in most other species of *Hyperaspis* elytra are punctured as strongly as, or stronger than, the pronotum), that of the under side very dense and strong, the space within the femoral lines has some shallow but very large punctures. Under side black or piceous, tibiae and tarsi yellow, mouth parts piceous or yellow. Prosternal carinae like those in *octonotata*, femoral lines evenly arcuate, only touching the posterior margin or running for a short distance parallel to it. Penis (pl. 5, fig. 136)

rather broad at base, with a tubercle located on the convex side closer to the base than to the apex, narrowed distally. Female genitalia as in *octonotata*.

Length of the body, 2.1-2.6 mm.; width, 1.7-2.1 mm.

Geographic distribution.—Localities as follows:

Utah: Kanab (SC).

Colorado: Paonia, Canon City (NMC), Glenwood Springs (CASC).

New Mexico: Las Vegas Hot Springs, Santa Fe (NMC).

Arizona: Kaibab Forest, Wupatki, Grand Canyon, Wickenburg, Peach Springs, Ashfork, Phoenix, Mesa, Globe, Walnut, Oracle, Hot Springs, Littlefield (on *Pluchea sericea*), Williams, Cochise County, Palmerly, Benson, Santa Catalina Mountains, Tucson, Santa Rita Mountains, Nogales, Pinal Mountains.

Nevada: Glendale (on *Chrysothamnus paniculatus*, NMC).

California: San Luis Obispo County, Pinnacles National Monument, Santa Barbara, Mojave, Hesperia, Palmdale, Fort Tejon, Pasadena, Jacumba, San Diego, Palm Springs.

Mexico: Sonora Guaymas (NMC).

Remarks.—Casey believed this species to be a relative of *quadrioculata*, with which it has little in common except a similarity of the elytral pattern. It is a relative, though by no means a close one, of *octonotata*.

***HYPERASPIS BENSONICA DISRUPTA*, new subspecies**

PLATE 2, FIGURE 52

Differs from the typical form by having the marginal vitta broken into separate humeral and marginal spots, the first of which is triangular and the second semicircular. The discal spot longitudinally oval (in one individual discal spot absent). Genitalia identical with those of the typical form.

Type.—In collection of F. T. Scott.

Paratype.—U.S.N.M. No. 54199.

Geographic distribution.—Localities as follows:

California: Kern County, 4 ♀♀ and 3 ♂♂ including the type (SC), Coalinga, 3 ♀♀ and 2 ♂♂, on juniper infested by a species of mealybug (SC), Pinnacles National Monument (CASC), San Luis Obispo County, 1 ♀ (SC), Lebec (CASC), Mount Lowe, 1 ♂ (Th. Dobzhansky).

Remarks.—This is a rather indistinct race of *bensonica* which is given here a name to prevent its confusion with *quadrioculata* subsp. *notatula* having a very similar elytral color pattern; the two species can be distinguished by the body shape which is more rounded and more convex in *bensonica*, and, of course, by structural characters. A tendency toward the breaking up of the marginal vitta into the

constituent spots is noticeable in specimens of *bensonica* coming from California, and seldom in those from Arizona; such specimens constitute a transition between the typical *bensonica* and subsp. *disrupta*.

HYPERASPIS CHAPINI, new species

PLATE 2, FIGURE 55

Broadly oval, strongly convex. In males head yellow with a transverse black stripe on the vertex, mouth parts brown, pronotum narrowly yellow on the anterior margin and with a yellow stripe which is from one and a half to two and a half times longer than wide on the lateral margin; in females head black, mouth parts dark brown, pronotum with a yellow stripe laterally which is from two and a half to four times longer than wide. Elytra with yellow marginal and apical spots only, the former lying slightly behind the middle of the length of the margin, semicircular or longitudinally oval, the latter rounded or transversely oval. Pronotum, elytra, and the under side rather densely and finely punctured, the punctures of the elytra only slightly, if at all, stronger than those on the pronotum. Legs black with brownish-yellow tibiae and tarsi in females, yellow with black hind femora in males, sides of the abdomen piceous in some individuals. Prosternal carinae short, femoral lines broad, semicircular, not quite attaining the posterior margin of the segment. Penis (pl. 4, fig. 110) much shorter than the broad paramera, strongly asymmetrical, resembling those of the species of the *gemma* group more than that of *octonotata*. The capsule of the spermatheca spheroidal, the connecting duct short, basal portion relatively large, with a small appendix.

Length of the body, 2.2-2.7 mm.; width, 1.7-2.1 mm.

Type and 33 paratypes.—U.S.N.M. No. 54200.

Geographic distribution.—Localities as follows:

Idaho: Filer (type), Jerome, Hubbs Butte, Bliss, Castleford, Twin Falls, Holister, Amsterdam, Declo, Hazelton, Wendell, Burley, Tuttle, Buhl, Kimama, Hagerman (35 specimens, all from Wind Vane traps, NMC).

Remarks.—This very distinct species bridges to a certain extent the gap between the *octonotata* and the *gemma* groups. It is named in honor of Dr. E. A. Chapin, of the United States National Museum.

III. GEMMA GROUP

This is a large group with many species in Central and South America, and rather abundantly represented in the western United States. The elytral pattern consists of a marginal spot or a marginal vitta, a discal spot located in front of the middle of the length of the

elytron, and an apical spot which in some species is heart-shaped. Penis and the paramera short and broad.

HYPERASPIS PRATENSIS PRATENSIS Leconte

PLATE 2, FIGURE 47

Hyperaspis pratensis LECONTE, 1880, p. 188.—CROTCH, 1873, p. 380.—SCHAEFFER, 1908, p. 126.

Hyperaspis triplicans CASEY, 1924, p. 163.

Hyperaspis triplicans microsticta CASEY, 1924, pp. 163-164.

Rounded oval, subhemispherical. In the male head and mouth parts yellow, in females respectively black and brown. Pronotum with strongly converging sides, in both sexes with large yellow spots laterally, the inner margins of which are convex inward. Elytral spots relatively small in comparison to other species of the *gemma* group, the marginal one semicircular, the discal and apical ones rounded. Pronotum densely but obsoletely punctate, elytra somewhat less densely but much more strongly, the under side densely but strongly punctate. Legs yellow, abdomen piceous on sides. Prosternal carinae moderately long, femoral lines broad, for a certain distance running parallel to the posterior margin, the outer parts becoming obsolete before reaching the sides of the segment. Penis (pl. 4, fig. 109) very short and broad, strongly asymmetrical; paramera short, spoon-shaped, densely covered with hair; basal plates well developed, rather long and broad. Female genitalia unknown.

Length of the body, 2.5-3.7 mm.; width, 2.1-2.6 mm.

Geographic distribution.—Localities as follows:

New Jersey: Atco (NMC), Hopatcong (SC).

North Carolina: Southern Pines (type of *triplicans*, CC).

Ohio: State record (NMC).

Illinois: southern part (NMC).

Missouri: State record (NMC).

Iowa: County No. 54 (SC).

Remarks.—*Triplicans* Casey is, as shown by the type, a synonym of *pratensis* Leconte. Casey's subspecies *microsticta* is represented by a single individual from the same locality as the typical form, and seems to be nothing more than a diminutive, probably underfed, specimen. The species seems to be a rare one.

HYPERASPIS PRATENSIS MEDIALIS Casey

PLATE 1, FIGURE 5

Hyperaspis medialis CASEY, 1899, p. 123.

Smaller than the typical form, slightly less strongly convex. The elytral spots relatively much larger, the marginal and apical ones

broadly oval. Among the three males studied, one had a yellow anterior margin of the pronotum, in the other two this part was black, as in females. The punctulation of the elytra more dense and less deep than in the typical *pratensis*. Male genitalia (one male from Arizona studied) proved to differ from those of *pratensis* only in being smaller.

Length of the body, 2.2-2.6 mm.; width, 1.8-2.2 mm.

Geographic distribution.—Localities as follows:

Texas: Brownsville, Esperanza Ranch, Alpine, Davis Mountains.

Arizona: Williams, Cochise County, Palmerly, Santa Rita Mountains.

Remarks.—Despite the rather clear separation between the typical *pratensis* and *medialis*, I find no sufficient reason to treat them as distinct species. The identity of *medialis* with *sexverrucata* Gorham postulated by Schaeffer (Sci. Bull. Brooklyn Inst., p. 145, 1905) is more doubtful. I have seen a series of specimens of what I take to be *sexverrucata* from Granada, Nicaragua (NMC), and they appear to me to resemble *conspirans* Casey rather than *medialis*. Casey is mistaken in believing that the female of *medialis* has a pale head; his type series consists of males only.

HYPERASPIS PRATENSIS AEMULATOR Casey

PLATE I, FIGURE 6

Hyperaspis aemulator CASEY, 1908, p. 413.

Generally intermediate in external characters between the typical *pratensis* and the subspecies *medialis*. The elytral spots rather large, the discal one rounded, the apical one transversely oval, the marginal the smallest of the three, semicircular. Genitalia unknown.

Length of the body, 2.5-2.7 mm.; width, 2.0-2.2 mm.

Geographic distribution.—Localities as follows:

Arizona: Nogales (type, CC), Iluachuca Mountains (SC), Palmerly (SC), Graham Mountains (SC).

? **Iowa:** Panora (D. M. Johnson, 1 ♀, SC).

Remarks.—In my opinion, *aemulator* is simply a synonym of *pratensis*. I preserve the former name because the material available is too small to permit reaching a definitive conclusion. The single individual from Iowa resembles more the specimens I have seen from Arizona than those from the eastern United States.

HYPERASPIS CONSPIRANS Casey

PLATE I, FIGURE 1

Hyperaspis conspirans CASEY, 1908, p. 414.

Smallest among the species of the *gemma* group in the United States, broadly oval, strongly convex. In males head and mouth parts

yellow with a black stripe on the vertex which is much broader on the sides than in the middle, in females head black; pronotum in both sexes with large yellow spots laterally, the inner margin of the spots strongly arcuate, in males sometimes indications of a yellow anterior margin. Elytra with rather large spots, the marginal one elongate, at least twice longer than wide, the discal rounded, the apical one obliquely oval, at times with indications of the heart-shapedness characteristic of *gemma*. Punctulation moderately dense and rather fine. Legs pale, all femora and hind tibiae infuscate in females, only hind femora so in males, abdomen frequently piceous. Prosternal carinae reach farther forward than in *pratensis*, femoral lines semi-circular. Penis (pl. 4, fig. 107) relatively narrow, the tubercle on the convex side closer to the base than to the apex. Female genitalia as in *gemma* but smaller.

Length of the body, 1.9-2.3 mm.; width, 1.5-1.8 mm.

Geographic distribution.—Localities as follows:

Texas: Brewster County, Chisos Mountains (NMC).

Arizona: Prescott, Cochise County, Palmerly, Oracle, Chiricahua Mountains, Empire Mountains, altitude 5,000 feet, Nogales (type, CC).

Remarks.—This species may prove to be a race of *sexuerrucata* Gorham.

HYPERASPIS GEMMA Casey

PLATE I, FIGURE 4

Hyperaspis gemma CASEY, 1899, p. 123; 1908, p. 414.

Broadly oval, strongly convex. In males head and mouth parts yellow with a rudimentary black stripe on the vertex, in females head black, mouth parts brown. Pronotum with large yellow spots laterally, in males in addition with a rather wide yellow anterior margin; the width of the lateral spots is, in males, equal to that of the central black area of the pronotum, the inner margin with an indentation at one-third of the length. Elytral spots large; the marginal one extending from one-fifth to three-fifths of the length, from twice to three times longer than wide, its sides subparallel; the discal spot rounded or obliquely oval; the apical one heart-shaped; the color of the spots pale yellow. Punctulation of the pronotum and the elytra moderately sparse and fine, that of the under side somewhat stronger. Legs brown in females, tibiae and tarsi lighter, yellow in males, sides of the abdomen frequently piceous. Penis (pl. 4, fig. 108) relatively long and narrow, shorter than the paramera, with an obtuse tubercle at the middle of the length of the convex side. Capsule of the spermatheca spheroidal, the proximal portion short and broad, connecting duct rather short.

Length of the body 2.2-2.8 mm.; width, 1.8-2.2 mm.

Geographic distribution.—Localities as follows:

Texas: Brownsville (type, CC), El Paso (NMC), Alpine (CASC).

New Mexico: Las Vegas, Santa Fe.

Arizona: Hot Springs, Grand Canyon, Williams, Prescott, Fort Grant, Oracle, Santa Catalina Mountains (elevation 8,500 feet).

California: San Diego (NMC), Potholes, Imperial County (E. P. Van Duzee, CASC).

Mexico: Durango, Tepehuanes (CC).

HYPERASPIS FASTIDIOSA FASTIDIOSA Casey

PLATE I, FIGURE 2

Hyperaspis fastidiosa CASEY, 1908, p. 414.

Less broadly oval than other species of *gemma* group (except subspecies *septentrionis*), strongly convex. In males head and mouth parts yellow, a black transverse stripe on the vertex, pronotum yellow with a black quadrilobed design on the base, sometimes reduced to an uneven transverse stripe; in females head black becoming brown toward the labrum, mouth parts brown, pronotum black with large yellow spots laterally which are wider than long. Elytra with a marginal spot transformed into a marginal vitta extending from the base to beyond the middle, becoming gradually wider posteriorly; discal spot large, longitudinally oval; apical spot heart-shaped, frequently showing a tendency toward confluence with the marginal and discal spots, color of the spots from yellow to yellowish-white. Punctulation rather fine and sparse. Under side black or brownish, legs fuscous yellow in males, brown in females. Prosternal carinae moderately long, femoral lines semicircular. Penis (pl. 4, fig. 105) rather short and broad, asymmetry not clearly pronounced, obliquely cut at the distal end. Female genitalia like those of *gemma*.

Length of the body, 2.1-2.7 mm.; width, 1.6-1.9 mm.

Geographic distribution.—Localities as follows:

Colorado: Fort Garland (Th. Dobzhansky).

Arizona: Grand Canyon, Hot Springs, Peach Springs, Yuma.

Utah: Kanab, American Fork, American Fork Canyon.

Nevada: Las Vegas, Elko, Carson City, Reno.

California: Independence, Big Pine, Bishop, Olancho, Lone Pine, Kern County (on *Artemisia* sp., feeding on *Orthesia artemisiae*, F. T. Scott), Santa Paula, Los Angeles, San Diego (type, CC), Palm Springs, Potholes.

Oregon: Harvey County (SC), Umatilla, Union, Maupin, Klamath Agency.

Remarks.—This species has been described by Casey on the basis of a single specimen which is a female and not a male as thought by

Casey. The specimens from Utah and Oregon are intermediate between *fastidiosa* and *septentrionis*.

***HYPERASPIS FASTIDIOSA SEPTENTRIONIS*, new subspecies**

PLATE 2, FIGURE 48

Slightly more oblong and less convex than the type form, punctuation of the elytra finer but denser, color of the pale markings on the pronotum and the elytra greenish-yellowish-white. Marginal vitta usually confluent with the apical spot, and the latter with the discal spot, thus the elytra being pale with a black base, a black vitta along the suture, and another black vitta at one-third of the width of the elytron extending from the base to about three-fourths of the length. Genitalia as in the typical *fastidiosa*.

Length of the body, 2.2-2.8 mm.; width, 1.5-1.9 mm.

Type and 189 paratypes.—U.S.N.M. No. 54201.

Geographic distribution.—Localities as follows:

Wyoming: Yellowstone Park (NMC), Grand Teton Park (Th. Dobzhansky).

Idaho: Murtaugh (type, NMC), Hollister, Burley, Hubbs Butte, Hansen, Tuttle, Twin Falls, Paul, Castleford, Filer, Jerome, Gooding, Wendell, Buhl, Amsterdam, Hazelton, Declo, Milner, Bliss, Shoshone, Craters of the Moon, Ashton, Melba, American Falls, Rexburg (most of the specimens from Wind Vane traps).

Arizona: Grand Canyon (SC).

IV. *LATERALIS* GROUP

Here belongs the common species *lateralis* Mulsant which is greatly differentiated geographically, and several less widespread forms; as far as the writer is aware, this group is not abundant in the Tropics. The elytral pattern consists of a marginal vitta, a discal spot lying in front of the middle of the length of the elytron, and an apical spot. Penis short and broad, strongly asymmetrical, paramera much dilated, spoon-shaped.

***HYPERASPIS LATERALIS LATERALIS* Mulsant**

PLATE 2, FIGURE 39

Hyperaspis lateralis MULSANT, 1850, p. 657.—LECONTE, 1880, p. 187.—CASEY, 1899, p. 122.

Hyperaspis lacvipennis CASEY, 1899, p. 122.—BOWDITCH, 1902, p. 207.

Hyperaspis pinguis CASEY, 1899, p. 122.—BOWDITCH, 1902, p. 207.

Very broadly oval, strongly convex. In males head and mouth parts yellow, pronotum with the lateral and anterior margins narrowly yellow; in females head black, pronotum black with or with-

out reddish spots in the anterior angles. Elytral markings blood red or orange; marginal vitta extending from the base to two-fifths of the length of the margin, broad, parallel-sided, not produced inward along the base, although in some individuals decidedly broader anteriorly; discal spot round or slightly longitudinally oval; apical spot round or transversely oval. Punctulation dense but fine. Epimera of the mesosternum white in males, black in females; front legs, tibiae and tarsi of middle and hind legs brownish yellow in males, in females only tarsi brownish. Prosternal carinae fused not far from the anterior margin; femoral lines broadly arcuate, merely touching the hind margin of the first abdominal sternite, their external parts not reaching the sides of the segment. Sides and tip of the abdomen occasionally piceous. Penis (pl. 4, fig. 120) much shorter than the paramera, the latter very broad, their edges covered with dense and long hair. Capsule of the spermatheca retort-shaped (pl. 6, fig. 162), gradually passing into the connecting duct, basal portion with a short appendix.

Length of the body, 2.6-3.8 mm.; width, 2.3-3.0 mm.

Geographic distribution.—Localities as follows:

Colorado: Durango (Th. Dobzhansky).

Texas: Green Valley, El Paso.

New Mexico: Las Vegas, Fort Wingate, Las Cruces, Mesilla Park.

Arizona: Chiricahua Mountains, Rustler Park, Pima County, Apache Lake, Globe, Santa Catalina Mountains, Tucson, Nogales.

Nevada: Dixie, Elko.

California: San Francisco, Alameda, Oakland, Fairfax, Paraiso Springs, Redwood City, Sacramento, Fresno (on *Pseudococcus citri*), Sequoia Park, Mineral King, Monterey County, Carmel, San Luis Obispo County, Santa Barbara, Santa Paula, Ventura, Inglewood, Los Angeles, Pasadena, Soledad Canyon, Duarte, Pomona, San Bernardino, Riverside, between Big Pines and Palmdale, Independence, Bishop, Chino, Whittier, Elsinore, San Diego, Warners Springs, Pine Valley, Jacumba, Blythe, Needles. Common along California coast, especially on scale-infested Monterey cypress and *Araucaria*.

Mexico: Sonora (P. H. Timberlake collection), Aguascalientes (NMC).

HYPERASPIS LATERALIS MONTANICA Casey

PLATE 2, FIGURE 40

Hyperaspis montanica CASEY, 1899, p. 121.

Less broadly oval than the typical form, strongly convex; the yellow margins on the pronotum in males narrower, the elytral markings yellow instead of red, the discal and apical spots small, the marginal vitta narrow and produced along the base of the elytron for a distance about equal to twice its width. Genitalia identical.

Length of the body, 2.6-3.2 mm.; width, 2.0-2.5 mm.

Geographic distribution.—Localities as follows:

British Columbia: Pavilion (Th. Dobzhansky), Vernon, Skaha.

Montana: Helena (type, CC), Broadwater County (University of Minnesota collection).

South Dakota: Hill City (Th. Dobzhansky).

Wyoming: Yellowstone Park, Grand Teton Park, Worland, Gillette, Ucross.

Idaho: Jerome, Hubbs Butte, Burley, Wendell, Murtaugh, Paul, Buhl, Kimberly, Hollister, Gooding, Castleford, Tuttle, Declo, Amsterdam, Bliss, Wickahoney, Boise, Parma, Twin Falls, Cow Creek, Beaver Canyon, Pocatello, Craters of the Moon.

Washington: Toppenish, Wallula Gap, Yakima, Coulee City, Ewan, Lake Chelan.

Oregon: Riddle, Hermiston, North Powder, Ontario, Harvey County, Baker, Lake County, Summer Lake, Lakeview, Bend, Steen Mountains, Klamath Falls.

Colorado: Canon City, Dixon, Estes Park, Fort Collins, Manitou.

Nevada: Steamboat Springs (Van Dyke, CASC).

California: Lava Beds National Monument; Coleville, Mono County (SC).

HYPERASPIS LATERALIS FLAMMULA Nunenmacher

PLATE 2, FIGURE 41

Hyperaspis lateralis var. *flammula* NUNENMACHER, 1911, p. 72.

Shape of the body as in subspecies *montanica*; elytral marking usually bright orange, but varying from yellow to bright red; the marginal vitta prolonged past the middle of the length of the elytron, greatly expanded and fused with a much enlarged discal spot; apical spot transversely oval. In some specimens the marginal vitta is fused also with the apical spot; at the humeral angles the vitta may or may not be produced along the base (as in *montanica*). Genitalia identical with those of the type form.

Geographic distribution.—Localities as follows:

Montana: State record (23 specimens, NMC).

Alberta: Medicine Hat (SC).

Wyoming: Ucross, Gillette, Worland, Sundance.

Colorado: Golden, Canon City, Manitou.

HYPERASPIS LATERALIS NIGROCAUDA, new subspecies

PLATE 2, FIGURE 42

Differs from the typical *lateralis* by having the apical spot obsolete; the marginal vitta broad, parallel-sided, the discal spot large, rounded or subtriangular; elytral markings blood red. Punctulation of the elytra very fine. Genitalia unknown.

Type and eight paratypes.—U.S.N.M. No. 54202.

Geographic distribution.—Localities as follows:

Colorado: Canon City (5 specimens, including the type, NMC), Paonia (E. C. Van Dyke, CASC).

Utah: Bryce Canyon (SC).

New Mexico: Las Vegas Hot Springs (NMC).

Arizona: Grand Canyon (reared from larvae collected from hawthorn, where they were feeding apparently on aphids, SC).

Nevada: Carson City, Dixie (SC).

California: San Francisco (1 individual, SC).

HYPERASPIS LATERALIS OMISSA Casey

PLATE 2, FIGURE 43

Hyperaspis lateralis var. *omissa* CASEY, 1899, p. 122.

Oval, somewhat less convex than other races of *lateralis*, elytra very finely punctulate, shining. Elytral marking blood red, the discal spot obsolete, the marginal vitta either as in the typical *lateralis* or as in *montanica*, the apical spot large, usually extended along the outer margin, the anterior boundary of the spot usually straight. Genitalia identical with those of the typical *lateralis*.

Length of the body, 2.8-3.2 mm.; width, 2.1-2.4 mm.

Geographic distribution.—Localities as follows:

New Mexico: Las Vegas Hot Springs (36 specimens, NMC), Santa Fe (CASC).

Arizona: Grand Canyon (type, CC), Bright Angel (1 specimen, NMC).

Utah: Salt Lake City (NMC), Cranc Valley (SC).

Nevada: Dixie (1 specimen, SC).

California: Placer County (3 specimens, P. H. Timberlake collection).

HYPERASPIS LATERALIS WELLMANI Nunenmacher

PLATE 2, FIGURE 44

Hyperaspis wellmani NUNENMACHER, 1911, p. 72.

Body size and shape intermediate between *lateralis lateralis* and *lateralis montanica*; elytral markings yellow or orange, marginal vitta narrow at humeral angles, not produced along the basal margin, distinctly increasing in width posteriorly; the discal and apical spots small, rounded; genitalia identical with those of the typical form.

Geographic distribution.—Localities as follows:

Washington: Yakima (5 specimens, NMC), Toppenish (2 specimens, SC).

Idaho: Craters of the Moon (1 specimen, SC).

Utah: American Fork (1 specimen, NMC).

Nevada: Goldfield (2 cotypes in C. W. Leng and H. L. MacKenzie collections).

California: State record (NMC).

Remarks.—In his description of *wellmani* Nunenmacher states that the larvae of this form are "strikingly different" from those of *lateralis* but omits to describe the nature of the difference. According to the original description, *wellmani* should have deeper foveae for the reception of the hind tibiae than *lateralis*, but I am unable to see this difference either in the two cotypes which I have examined or in other specimens that otherwise fit Nunenmacher's description.

HYPERASPIS LATERALIS IDAE Nunenmacher

Hyperaspis idae NUNENMACHER, 1912, p. 450.

Differs from the typical *lateralis* in having the marginal vitta reduced to a semicircular spot located at about one-third of the external margin of the elytron. Genitalia identical with those of the typical form.

Geographic distribution.—Localities as follows:

California: Guerneville (cotype, C. W. Leng collection), Klamath Glen (3 individuals, Th. Dobzhansky), San Francisco (1 specimen, SC), Redwood City (14 specimens, SC), Lagunitas (E. C. Van Dyke, CASC).

Remarks.—*Hyperaspis lateralis* shows a great individual as well as geographic variability both in the structural characters and in the color pattern. This variability is very instructive and would repay a closer study. Certain individual variants were described as separate species (*laevipennis* Casey, *pinguis* Casey), the invalidity of which is easily demonstrable if larger series are studied. Geographically, the different characters vary to a certain extent independently; for example, individuals which are structurally *montanica* may have either *montanica* or *flammeola* color patterns. The color patterns may be subdivided into several discrete types the intermediates between which are sufficiently infrequent to permit a clear separation; these types of patterns are used above as chief characteristics of the several subspecies. Since apparently only a few genes, or gene alleles, are involved in the production of the types of patterns, the latter may co-exist in the same population. Thus, both *montanica* and *flammeola* are recorded for several localities in Wyoming, the preceding two as well as *nigrocauda* at Canon City, Colo., *montanica* and *wellmani* at Yakima, Toppenish, and Craters of the Moon. A series of 155 specimens collected at Redwood City, Calif., by F. T. Scott contained 14 specimens of *idae*, 132 of typical *lateralis* and 9 intermediates. However, it must be emphasized that the relative frequencies of various color patterns are unlike in different geographic regions; among almost 2,000 individuals from southern California nothing but *lateralis*

was found. Moreover, the subspecies are characterized not only by color patterns but by structural differences as well; the latter appear to be genetically more complex and, hence, geographically more stable. The advantage of using color patterns for characterizing subspecies is obvious, namely, simplicity of classification. The use of the structural differences would involve an extensive statistical work, but the results obtained would be, in a sense, more reliable.

HYPERASPIS EXCELSA Fall

PLATE 2, FIGURE 45

Hyperaspis excelsa FALL, 1901, p. 232.

Large, broadly oval, strongly convex. In males head and mouth parts yellow, pronotum with yellow lateral and anterior margins, the former being broader than the latter; in females head and pronotum black, mouth parts brown. Elytra with a blood-red marginal vitta extending from the humeral angle to about three-fifths of the length, deflected from the margin in its posterior part and broadly confluent with the enlarged discal spot; a small transversely oval apical spot may or may not be present. The upper surface polished, shining, pronotum minutely and rather sparsely punctulate, elytra still more sparsely and very delicately so, punctulation of the under side rather dense and moderately strong. Coloration of the under side, prosternal carinae, and femoral lines as in *lateralis*. Genitalia differ from those of *lateralis* chiefly in size, but penis seems to have a more pronounced tubercle on the convex side (pl. 4, fig. 114).

Length of the body, 3.6-4.2 mm.; width, 2.9-3.4 mm.

Geographic distribution.—Localities as follows:

California: Pomona (cotype, NMC), San Bernardino County, Los Angeles (feeding on *Pseudococcus yuccae*, NMC, SC), Pasadena (CASC), total of 8 individuals examined.

Remarks.—A close relationship as well as a specific distinctness of *excelsa* and *lateralis* are beyond doubt.

HYPERASPIS TAEDATA Leconte

PLATE 2, FIGURE 46

Hyperaspis taedata LECONTE, 1880, p. 187.

Body shape as in *lateralis* and *excelsa* but size much smaller. Head yellow with a transverse bilobed black stripe on the vertex (male?), or, in addition, with a black epistoma (female?), pronotum with triangular yellow spots in anterior angles (female?) or with a rather broad yellow stripe on the lateral margin (male?). The color pattern

of the elytra as in *excelsa*. Punctulation of the pronotum dense but rather fine, that of the elytra much stronger, that of the under side dense and medium strong. Pronotal carinae and femoral lines as in *lateralis*, coloration of the under side piceous, mesosternal epimerae in the male apparently dark. Genitalia unknown.

Length of the body, 2.4 mm.; width, 1.8 mm.

Geographic distribution.—Localities as follows:

Florida: State record (C. W. Leng collection), Enterprise (NMC).

Remarks.—Although this species is altogether insufficiently known, there is little doubt that it is separate from *excelsa* which it most closely resembles.

HYPERASPIS LUGUBRIS (Randall)

PLATE 2, FIGURE 70

Coccinella lugubris RANDALL, 1838, p. 52.—MULSANT, 1850, p. 1051.—LECONTE, 1880, p. 188.—CASEY, 1899, p. 128.

Hyperaspis jucunda LECONTE, 1852, p. 134.

Hyperaspis lecontei CROTCH, 1874, p. 233.

Hyperaspis venustula MULSANT, 1850, p. 671.

Hyperaspis separata CASEY, 1924, p. 165.

Elongate oval, little convex, broadly rounded behind, sides of the elytra rather feebly arcuate in their middle part. In males head and the pronotum ochreous yellow, the latter darker at the base in front of the scutellum; in females head yellow, pronotum with yellow lateral margins, the anterior margin in some individuals also narrowly yellow, the width of the yellow stripes variable and their internal boundaries indistinct. Elytra with a yellow or ochreous-yellow marginal vitta extending from the base to two-thirds of the length, expanded posteriorly in the part corresponding to the marginal spot and constricted immediately in front of the expansion, a longitudinally oval discal spot equidistant from the suture and from the margin, located definitely in front of the middle of the length, and a rounded or longitudinally oval apical spot lying somewhat closer to the suture than to the external margin at four-fifths of the length of the elytron. Pronotum and the elytra alutaceous, the former densely but very minutely punctulate, the latter less densely but more strongly so, punctulation of the under side very dense but fine, except on the sides of the mesosternum, where it is dense and strong. Under side brownish yellow, mesosternum and metasternum and the base of the abdomen darker, brown or black. Prosternal carinae low but reaching far forward, femoral lines almost reaching the posterior margin, running for a distance parallel to the latter, becoming angular exter-

nally, and disappearing without attaining the sides of the segment. Penis and paramera very short and broad, the former distinctly shorter than the latter (pl. 6, fig. 152), strongly asymmetrical; basal plates powerfully developed. Female genitalia unknown.

Length of the body, 2.4-3.3 mm.; width, 1.6-2.4 mm.

Geographic distribution.—Localities as follows:

Massachusetts: State record (SC).

New York: West Point (W. Robinson, 1 ♀, NMC), Pinclawn (Schaeffer, SC).

New Jersey: Greenwood (C. W. Leng collection).

Kansas: Topcka, Riley County (NMC).

Iowa: Iowa City (C. W. Leng collection).

Colorado: State record (NMC).

Texas: State record (NMC).

Remarks.—*Hyperaspis lugubris* has no close relatives in the fauna of the United States. It is placed in the *lateralis* group only on the basis of a similarity of the male genitalia, which may prove to be accidental. It may be noted that the head and pronotal coloration in females of *lugubris* resembles that encountered in males of many other species of *Hyperaspis*.

V. PROBA GROUP

Body rounded oval, strongly convex, almost hemispherical. The elytral pattern consists of a marginal vitta, a discal spot, and two apical spots lying at the same level and forming a row of four spots across the apical parts of the two elytra; they may be termed the inner and the outer apicals. Penis short and broad, paramera tapering toward the end, the end covered with a small tuft of short bristles—a condition found in no other group of species of *Hyperaspis* in the United States.

HYPERASPIS PROBA PROBA (Say)

PLATE I, FIGURE 35

Coccinella proba SAY, 1826, p. 303.—MULSANT, 1850, p. 674.—LECONTE, 1880, p. 188.—CASEY, 1899, p. 122.

In the male head yellow or yellowish white, pronotum with yellow subquadrate spots on the lateral margins, and with a narrow vitta of the same color on the anterior margin, antennae, front legs, knees, tibiae and tarsi of middle and hind legs brownish yellow; in the females head black, pronotum yellow laterally, the yellow part being longer than wide, coloration of the under side like that in the males. The elytral spots yellow or yellowish white, seldom orange red; the

discal spot round or slightly transversely oval, lying a little closer to the external margin than to the suture; the marginal vitta wanting; the two apical spots rounded, much smaller than the discal one, and occasionally reduced to a point, or even disappearing altogether. Head, pronotum and the elytra densely and finely punctulate, the elytral punctures somewhat stronger than the pronotal ones, punctulation of the under side very dense and rather coarse. Prosternal carinae forming a very sharp angle, and reaching up to a point not far from the anterior margin; femoral lines flatly arcuate, not reaching the posterior margin, externally disappearing before attaining the sides of the first abdominal sternite. Penis (pl. 5, fig. 145) shorter than the paramera, very broad at base; basal plates with a toothlike process. Basal portion of the spermatheca (pl. 6, fig. 163) provided with a very large strongly chitinated appendix, the size of which exceeds that of the basal portion proper; the capsule rounded, suddenly giving rise to the connecting duct.

Length of the body, 2.1-3.0 mm.; width, 1.7-2.5 mm.

Geographic distribution.—Found generally over eastern United States from Massachusetts to Florida and westward to Minnesota, South Dakota, Nebraska, Kansas, Arizona, New Mexico, and Texas. A specimen has been seen labeled as from Fresno, Calif. (NMC).

Remarks.—A small individual from New Mexico has been described by Casey (1899, p. 123), as variety *trinifer*; this variety is supposed also to have the apical spots of the same size as the discal one. The final disposition of this name must await further data. The finding of *proba* in California is somewhat doubtful.

HYPERASPIS PROBA WEISEI Schaeffer

PLATE I, FIGURE 17

Hyperaspis weisei SCHAEFFER, 1908, p. 126.

Differs from the typical form in being somewhat more strongly convex, in having a finer punctulation of the elytra, and in possessing a marginal spot or a marginal vitta. The elytral spots larger than in the typical form, the outer apical one almost reaching the external margin; the marginal spot either semicircular or produced cephalad to form a marginal vitta which is much broader posteriorly than anteriorly. Genitalia unknown.

Length of the body, 2.6-2.7 mm.; width, 2.3 mm.

Geographic distribution.—Localities as follows:

Texas: Brownsville (Schaeffer, cotype, SC), Davis Mountains, (J. N. Knull, SC).

Remarks.—In view of the scarcity of the available material, my treatment of *weisei* as a subspecies of *proba* is admittedly hazardous. The two forms are, however, so similar externally that intermediates between them are to be expected; the specimens of *proba* from the southern part of its distribution have a finer punctulation than the northern ones, thus being, to a degree, intermediate between the northern *proba* on one hand and *weisei* on the other.

HYPERASPIS GLOBULA Casey

PLATE 2, FIGURE 49

Hyperaspis globula CASEY, 1899, p. 124

Small, rounded, oval, subhemispherical. Head yellowish white in males, black in females; pronotum with pale yellow subquadrate spots laterally, in males, in addition, with a pale anterior margin. Elytra with a large, rounded, yellowish-white discal spot located slightly closer to the suture than to the external margin, and behind the middle of the length. Punctulation of the pronotum dense and strong, that of the elytra stronger still, that of the under side moderately strong, except that on the metasternum the punctures are very large and shallow. Mouth parts, front legs, tibiae and tarsi of the middle and hind legs, and, in some of the males but not in others, mesosternal epimerae pale. Prosternal carinae very long, practically attaining the anterior margin; femoral lines very flat, their external part forming a sharp angle with the posterior border, not attaining either the posterior or the side margins. Male genitalia (pl. 5, fig. 150) of the same type as in *proba* but much smaller, penis almost as long as the paramera, basal plates without teeth. Spermatheca (pl. 6, fig. 164) with a rudimentary capsule and a large appendix on the basal portion, which, however, does not attain the degree of hypertrophy it does in *proba*.

Length of the body, 1.8-2.0 mm.; width, 1.4-1.6 mm.

Geographic distribution.—Localities as follows:

Texas: Brownsville, Esperanza Ranch, Hidalgo County (NMC, SC).

Mexico: Tampico (NMC).

Remarks.—This small species is very interesting since it constitutes a bridge between the *proba*, *connectens*, and *binotata* groups of species which otherwise would be quite isolated. At the same time *globula* is obviously a highly specialized form (reduction of the capsule of the spermatheca), which in any case prevents its consideration as an ancestor of the other groups of forms.

VI. *CONNECTENS* GROUP

The fauna of the United States has only two species of this group, both of which occur only in the extreme South, close to the Mexican border. The elytral pattern consists of large discal and apical spots which may or may not be confluent with each other. Male genitalia are characterized by small basal plates and broad paramera the basal portions of which are overdeveloped at the expense of the basal plates. The capsule of the spermatheca spherical rather than retort-shaped.

***HYPERASPIS CONNECTENS* (Thunberg)**

PLATE 2, FIGURE 67

Coccinella connectens THUNBERG, in Schönherr, 1808, p. 157.—MULSANT, 1850, p. 662.

Hyperaspis lenqi SCHAEFFER, 1905, p. 144; 1908, p. 126

Broadly oval, moderately convex. Head and mouth parts yellow in males, black in females. Pronotum in both sexes broadly yellow laterally, the internal boundaries of the yellow areas more or less straight, the anterior margin of the pronotum yellow in males. The elytral spots yellow, the discal one rounded or transverse, the apical one large, attaining the external margin but not the suture, its inner outline concave, usually broadly confluent with the discal spot. Head and the pronotum densely but finely punctulate, interstices barely perceptibly alutaceous, punctulation of the elytra moderately sparse and strong, that of the under side rather sparse and fine. Tibiae and tarsi yellow, sides of the abdominal sternites brown. Prosternal carinae short, femoral lines strongly arcuate, not attaining the posterior margin, their outer parts forming a sharp angle with the sides of the segments, usually reaching or almost reaching the anterior angles. Penis (pl. 4, fig. 116) shorter than the paramera, strongly asymmetrical, its base rather narrow, strongly expanded at the middle, and acuminate at the tip. The basal parts of the large spoon-shaped paramera densely covered with large pores; the basal plates very short. The capsule of the spermatheca almost spherical, the connecting duct long, basal portion elongate, provided with a short appendix.

Length of the body, 2.5-3.0 mm.; width, 2.0-2.3 mm.

Geographic distribution.—Localities as follows:

Texas: Brownsville, Esperanza Ranch, San Benito, Harlingen, Hidalgo County, Edinburg, Mission.

Arizona: Pima County, Phoenix, Palmerly, Tucson, Nogales, Huachuca Mountains.

Mexico: Orizaba (NMC).

Guatemala: Huehuetenango (Th. Dobzhansky), Guatemala City (Champion, NMC).

Honduras: State record (F. J. Dyer, NMC).

Nicaragua: San Marcos, Chinandega (NMC).

Jamaica: Kingston (NMC).

Haiti: Hinche, Boucan (H. L. Dozier, NMC).

Santo Domingo: Santo Domingo, Halpa (on cotton, U. C. Leftin, NMC).

Puerto Rico: Bayamon (A. Busck, NMC).

Remarks.—I see no difference between *lengi* Schaeffer and *connectens* (Thunberg), except that the frequency of the confluence of the discal and apical spots is greater in the populations from Texas than in those from Arizona or Central America. Genitalia of a few specimens from Nicaragua proved to be identical with those of Texas specimens.

HYPERASPIS ROTUNDA Casey

PLATE 2, FIGURE 66

Hyperaspis rotunda CASEY, 1899, p. 123.

Hyperaspis rotundata (Casey) KORSCHITSKY, 1931, p. 195.

Broadly oval, somewhat obtusely rounded behind, strongly convex. Coloration of the head and the pronotum as in *connectens*, except that the yellow spots on the lateral portions of the pronotum larger and tending to become wider posteriorly, so that the central black area appears constricted at base. Elytra with a large, pale yellow, longitudinally oval discal spot, and an apical spot of the same color extending from about the middle to the apical eighth of the external margin and attached to the latter; confluence of these spots has never been observed, the anterior margin of the apical one convex. Punctulation of the pronotum as in *connectens*, that of the elytra much sparser and rather fine, that of the under side stronger. Legs yellow, epimera and episterna of the mesonotum as well as the abdomen fuscous. Prosternal carinae strong, almost reaching the anterior margin; femoral lines much less strongly arcuate than in *connectens*, their outer parts forming sharp angles with the posterior margin, and not reaching the sides of the segment. Penis (pl. 4, fig. 113) shorter than the paramera, more or less uniformly broad, obtusely truncate distally; paramera spoon-shaped, basal plates more strongly developed than in *connectens*. The capsule of the spermatheca (pl. 6, fig. 166) more retort-shaped than in *connectens*, basal portion elongate and narrow.

Length of the body, 2.2-2.7 mm.; width, 1.8-2.0 mm.

Geographic distribution.—Localities as follows:

Texas: Brownsville, San Tomas.

Arizona: Phoenix, Sacaton, Tucson.

VI. BINOTATA GROUP

This group attains its greatest development in the Temperate Zone of North America, although a number of its species seem to be perfectly at home in the American Tropics. Moreover, the Old World species of *Hyperaspis* (including the type of the genus, *H. reppensis* Herbst), or at least a majority of them, belong here. The elytral pattern consists of a discal, or an apical, spot, or both; however, in some species the position of the spot is such as to make the homology with the spots of the basic pattern of the genus difficult—this is the only group where such a difficulty is encountered. Genitalia rather diversified: in some species penis is short and broad, and paramera broad and spoon-shaped, in others penis is long and narrow, paramera being slender and fingerlike. Intermediate conditions also occur, making it impossible to split the groups into more uniform subdivisions.

HYPERASPIS BINOTATA (Say)

PLATE 3, FIGURE 73

Coccinella binotata SAY, 1826, p. 302.—CROTCH, 1873, p. 380.—CASEY, 1899, p. 124.—MULSANT, 1850, p. 683 (partim).

Coccinella normata SAY, 1826, p. 302.

Coccinella affinis RANDALL, 1838, p. 50.—MULSANT, 1850, p. 1051.

Hyperaspis leucopsis MELSHEIMER, 1847, p. 179.—CROTCH, 1873, p. 380.

Hyperaspis conviva CASEY, 1924, p. 163.

Hyperaspis insolens CASEY, 1924, p. 164.

Broadly oval, strongly convex. In females head and pronotum black, in males head yellow with a black bisinuate stripe on the vertex frequently concealed by the margin of the pronotum, pronotum narrowly yellow on the lateral and the anterior margins. Elytra with a red or orange-red discal spot lying somewhat in front of the middle of the length, rounded or slightly transverse. Punctulation of the pronotum dense and moderately strong, interstices feebly or not at all alutaceous, that of the elytra as dense but stronger, that of the under side dense and strong. Under side black, front legs dark piceous in females, yellow in males. Prosternal carinae forming a very sharp angle, reaching far forward, femoral lines strongly arcuate, their middle parts running subparallel to the posterior margin of the segment, their outer parts angular. Penis (pl. 4, fig. 123) only slightly shorter than the paramera, long and narrow, knife-shaped, with straight sides, the end bluntly cut off; paramera long, fingerlike; basal plates moderately developed. Capsule of the spermatheca (pl. 6, fig. 165) nearly spherical, the basal portion large, with a small appendix.

Length of the body, 2.5-4.0 mm.; width, 2.0-3.3 mm.

Geographic distribution.—Found generally over eastern North America from Quebec to Florida and westward to Nebraska, Colorado, and Texas. The species reappears in California at Bishop (CASC).

Remarks.—This is probably the commonest species of *Hyperaspis* in the eastern United States. Casey's species *conviva* and *insolens* represent, as shown by examination of the types, merely individual variants of *binotata*, and should be treated as synonyms.

HYPERASPIS SIGNATA (Olivier)

PLATE 3, FIGURE 78

Coccinella signata OLIVIER, 1808, p. 1047.—MULSANT, 1850, p. 683.—LECONTE, 1880, p. 187.—CASEY, 1899, p. 122.

Externally resembles *binotata* Say. Body somewhat less broadly oval, more ovoidal in shape, sides of the elytra less arcuate in their middle part, the yellow anterior margin on the pronotum sometimes obsolete at the middle. Elytra each with two red spots: a discal one situated as in *binotata*, and an apical one which is much smaller than the discal, rounded or transversely oval, in some specimens reduced in size or obsolete. Penis (pl. 4, fig. 118) much shorter than the paramera, very broad, strongly asymmetrical, dilated distally, the end sharply cut off; paramera broad. Female genitalia as in *binotata*.

Length of the body, 2.7-3.7 mm.; width, 2.1-2.9 mm.

Geographic distribution.—Occurs from New York to Florida and westward to Arkansas and Texas.

Remarks.—*H. signata* and *binotata* were considered by most authors, including even Casey, to constitute a single species. On the basis of external characters their separation is indeed difficult, owing to a great range of variability exhibited by both of them. Nevertheless, examination of large series of specimens shows that two distinct modal points are represented in the population, and that the distribution of *signata* is on the whole more southerly than that of *binotata*. All doubt about the existence of a specific difference between them is removed by investigation of the male genitalia, where the structural difference is unexpectedly striking.

HYPERASPIS PINORUM Casey

PLATE 3, FIGURE 79

Hyperaspis pinorum CASEY, 1924, p. 162.

? *Hyperaspis incdita* MULSANT, 1850, p. 684.—CROTCH, 1873, p. 380.—CASEY, 1899, p. 124.

Broadly oval, moderately convex. In males head yellow, pronotum with subquadrate orange-yellow spots laterally and with a yellow

anterior margin, in females head black, pronotum with pale lateral spots as in the male but with the anterior margin black. Elytra with an orange or red discal spot, the spot rounded or obliquely oval, its center lying clearly caudad from the middle of the length of the elytron. Punctulation of the upper surface dense but rather fine, interstices feebly alutaceous, that of the underside very dense and strong. In males legs yellow, epimera of the mesosternum white, the abdomen piceous; in females the tibiae, tarsi, and tips of femora brownish yellow, abdomen black or with piceous spots on the sides of the abdominal sternites. Genitalia unknown.

Length of the body, 2.9-3.0 mm.; width, 2.1-2.3 mm.

Geographic distribution.—Localities as follows:

Delaware: Bethany Beach (L. J. Bottimer, SC).

North Carolina: Southern Pines (type and paratypes, CC).

Georgia: Barnesville (NMC), Milner, Clayton.

Florida: Tallahassee, Quincy, Navarre, Gainesville, Fort Walton, Lake City.

Alabama: Magazine Point (H. P. Löding, SC).

Remarks.—Casey (loc. cit.) describes this species as "convex, polished," which I do not find to be the case either in the type or in other specimens that I have examined. The identification of *inedita* with *pinorum* is uncertain since I have not seen the type of the former; the patria of *inedita* is given as North America. If their identity is confirmed, the species will, of course, have to change its name to *inedita* Mulsant.

HYPERASPIS HAEMATOSTICTA Fall

PLATE 3, FIGURE 77

Hyperaspis haematosticta FALL, 1907, p. 222.

Oval, moderately convex, sides of the elytra feebly arcuate, broadly rounded behind. In males head yellow, with or without a black stripe on the vertex, mouth parts brown, pronotum with a rather narrow yellow stripe on the anterior margin and with a two to four times broader one laterally; in females head and mouth parts black, pronotum either solid black or with a narrow yellow stripe laterally which varies in extent from a comma-shaped streak in the anterior angles to a fully developed stripe reaching the humeral angles. Elytra each with two blood-red spots: the discal one located just in front of the center of the disk and slightly closer to the suture than to the external margin, usually oblique but sometimes rounded, and a transversely oblique apical spot, which is wanting in some specimens. Punctulation of the upper surface dense but rather fine, that of the under side finer than in related species. Under side black in females with dark piceous tibiae and tarsi, in males legs brownish yellow except

for the dark hind femora, epimera of the mesosternum light brown, sides of the abdomen in both sexes brown. Prosternal carinae short. Penis (pl. 4, fig. 124) knife-shaped, resembling that of *binotata* but broader, paramera almost as long as the penis. The capsule of the spermatheca retort-shaped.

Length of the body, 2.8-3.6 mm.; width, 2.0-2.6 mm.

Geographic distribution.—Localities as follows:

New Mexico: Las Vegas (38 specimens, NMC).

Arizona: Chiricahua Mountains (SC), Williams (NMC).

HYPERASPIS LEWISI Crotch

PLATE 3, FIGURE 76

Hyperaspis lewisi CROUCH, 1873, p. 380.—LECONTE, 1880, p. 187.

Hyperaspis maneei CASEY, 1924, p. 163.

Oval, compressed from the sides, lateral margins of the elytra nearly straight in their middle parts, truncate behind, pronotum only slightly narrowed anteriorly, the anterior margin feebly arcuate, the angles turned downward. In males the head, lateral margins of the pronotum broadly and the anterior margin narrowly yellow, in females head and pronotum black, the latter fuscous laterally in some individuals. Elytra with a large yellow or orange discal spot extending from the basal fourth or fifth to behind the middle of the length, and from the inner third of the width to the lateral margin which is narrowly black. Punctulation of the pronotum dense but very fine, that of the elytra almost as dense and only slightly stronger, that of the under side not dense and very fine, the middle of the metasternum and of the first abdominal sternite virtually impunctate, polished, the space enclosed by the femoral lines with a few rather coarse punctures. In females tibiae and tarsi brown, in males legs yellow or yellowish brown. Prosternal carinae exceptionally short, converging but not fused anteriorly, the anterior part of the prosternum without trace of a carina; femoral lines semicircular or slightly flattened in the part where they approach the posterior margin. Genitalia unknown.

Length of the body, 3.0-3.8 mm.; width, 2.1-2.5 mm.

Geographic distribution.—Localities as follows:

New York: West Point (W. Robinson, NMC), Bear Mountain (F. M. Schott, SC).

Maryland: Great Falls (L. L. Buchanan, NMC).

North Carolina: Southern Pines (Manee, type and paratypes, CC, NMC).

Kentucky: Louisville (H. Soltau, NMC, SC).

Remarks.—This is a very distinctive species which is only provisionally placed in the *binotata* group. It has no known close relatives.

HYPERASPIS LEACHI Nunenmacher

PLATE I, FIGURE 32

Hyperaspis leachi NUNENMACHER, 1934, p. 19.

Broadly oval, moderately convex, sides of the elytra feebly arcuate, broadly rounded behind, head and pronotum relatively short and broad, the latter only slightly narrower anteriorly than posteriorly. In the male head yellow, pronotum with a narrow yellow stripe on the anterior margin (the margin itself remaining black) and a wider stripe on the lateral margin which is produced inward for a short distance along the base; in the female head and pronotum black, the latter with a yellow stripe laterally which is more than twice as long as wide. Elytra with a large orange-colored area extending from the basal fourth or fifth to the apical fourth or fifth of the length, and from the external margin which is narrowly black to one-fourth of the width from the suture; the outline of the orange area uneven, especially in the callus area where a black spur projects into it. Punctulation of the head and the pronotum dense but fine, that of the elytra almost as dense but still finer, that of the under side somewhat coarser. In the female the tibiae, tarsi, and the front legs yellowish brown, in the male legs yellow, posterior femora fuscous. Prosternal carinae as short as in *lewisi* but clearly fused at their anterior ends, femoral lines rather flat, their outer parts forming sharp angles with the posterior margin, with which their middle parts are subparallel. Genitalia unknown.

Length of the body, 2.5-2.8 mm.; width, 2.1-2.4 mm.

Geographic distribution.—Localities as follows:

California: San Diego County (1 ♂, F. T. Scott, SC), Kern County (1 ♀, F. T. Scott, SC).

Remarks.—Nunenmacher correctly believes this species to be related to the Mexican *panzosae* Gorham, and in fact it may be only a race of the latter. I have seen *panzosae* from Mexico City (NMC), but my notes on it are unfortunately inadequate. The following two species appear to be also rather closely related. The two individuals of *leachi* which I have examined are larger than the dimensions given by Nunenmacher indicate, namely 2.20 mm. in length and 1.75 in width.

HYPERASPIS REGALIS Casey*Hyperaspis regalis* CASEY, 1899, p. 123.

Broadly oval, rather strongly convex. In the type, which is apparently a female, pronotum with subquadrate, internally rounded yellow spots on the lateral margin. Elytra with a large orange spot

extending from the basal fourth to the apical fifth of the length and from the inner to the outer fourth of the width of the elytron. Punctulation dense but very fine. Legs black, except for the light brown anterior tibiae and tarsi. Genitalia unknown.

Length of the body, 3.0 mm.; width, 2.2 mm.

Geographic distribution.—Locality as follows:

Florida: Jacksonville (type, CC).

HYPERASPIS NIGROSUTURALIS Blatchley

Hyperaspis nigrosuturalis BLATCHLEY, 1918, p. 420.

Very broadly oval, strongly convex. In the female head and pronotum black. Elytra orange red with a black sinuate fascia basally reaching to one-sixth of the length, and black stripes on the suture and on the external margin, the sutural stripe being twice as wide as the marginal one, and both becoming wider posteriorly. Punctulation of the head and the pronotum dense and moderately strong, that of the elytra almost as dense but not quite as strong as that of the pronotum, that of the under side dense and medium strong. Legs black, front tarsi piceous. Prosternal carinae very short, femoral lines broad, their middle parts running parallel to the posterior margin. Genitalia unknown.

Length of the body, 3.1 mm.; width, 2.5 mm.

Geographic distribution.—Locality as follows:

Florida: Lake Alfred (1 ♀, R. Miller, NMC).

Remarks.—This species is very close to, and in fact may represent only an indistinct race of, the Mexican *imperialis* Casey. The latter, of which I have seen only the Casey type, differs only in having the lateral parts of the pronotum yellowish red, which may represent a sexual or a racial difference. In view of the extreme scarcity of the material, it is wise to defer the decision on the identity of *nigrosuturalis* and *imperialis* to a future date.

HYPERASPIS BICENTRALIS BICENTRALIS Casey

PLATE 3, FIGURE 75

Hyperaspis bicentralis CASEY, 1899, p. 124.

Rounded oval, strongly convex, subhemispherical. In males head yellow with a black bisinuate band or with two black spots on the vertex, pronotum with a very narrow yellow stripe on the anterior and with somewhat broader stripes of the same color on the lateral margins; in females head and pronotum black. Elytra with a large

circular red discal spot located closer to the margin than to the suture and in front of the middle of the length of the elytron. Punctulation of the upper surface dense but fine, that of the under side dense but much coarser. Mouth parts, front legs, tibiae and tarsi of the middle and hind legs reddish brown, the whole abdomen or only its sides piceous. Prosternal carinae medium long, a part of the femoral lines subparallel to the posterior margin of the segment. Genitalia (pl. 4, fig. 117) resembling those of *signata* but penis relatively longer and narrower.

Length of the body, 2.6-3.2 mm.; width, 2.2-2.7 mm.

Geographic distribution.—Localities as follows:

Texas: Austin, New Brownfels, La Vaca County, Kerrville, Victoria, Dallas, Paris, Uvalde, College Station, Cypress Mills.

Oklahoma: Mountain Park (on *Lecanium corni*).

HYPERASPIS BICENTRALIS MAJOR, new subspecies

Differs from the type form by a large size, a pale orange or yellow color of the discal spot, and a darker coloration of the under side of the body. In females head, pronotum and under side black, antennae and tarsi dark piceous; in males head, a narrow stripe on the anterior and a somewhat wider one on the lateral margins of the pronotum yellow, mouth parts, tibiae and tarsi of the front and middle legs brown. Genitalia unknown.

Length of the body, 3.5-3.7 mm.; width, 3.0-3.1 mm.

Type and four paratypes.—U.S.N.M. No. 54203.

Geographic distribution.—Locality as follows:

Illinois: Riverside (4 ♂♂ and 1 ♀ including the type, Geo. M. Greene, NMC).

Remarks.—This is a well-pronounced race of *bicentralis* or else an independent species: the lack of material from States lying between Illinois and Texas does not permit a final decision at present.

HYPERASPIS CENTRALIS WICKHAMII Casey

PLATE 3, FIGURE 74

Hyperaspis wickhami CASEY, 1899, p. 124.

Hyperaspis centralis (Mulsant) BOWDITCH, 1902, p. 207.

Body subhemispherical. In males head yellow, pronotum with subquadrate yellow spots laterally and a yellow anterior margin; in females head black, pronotum with yellow lateral spots. Elytra with an orange-yellow spot located clearly posteriorly from the middle of the length of the elytron, closer to the margin than to the suture; the spot rounded or, in individuals in which it is very large, longitudinally

oval. Punctulation dense and strong, especially on the sides of the metasternum. In males mouth parts and legs yellow, epimera of the mesosternum white, in females mouth parts, tibiae and tarsi brown; sides of the abdominal sternites piceous in both sexes. Prosternal carinae and femoral lines as in *bicentralis*. Penis (pl. 4, fig. 121) much shorter than the paramera, very short and broad, one side strongly concave, the other convex with a triangular process, the distal end obliquely cut off. Paramera broader than in other species of *binotata* group. Female genitalia unknown.

Length of the body, 2.8-3.5 mm.; width, 2.1-2.8 mm.

Geographic distribution.—Localities as follows:

Texas: Brownsville (type, CC), Esperanza Ranch, San Tomas, Los Borregos, Laredo, San Diego, Uvalde, Austin.

Remarks.—Bowditch (1902) believed *wickhami* to be a straight synonym of *centralis*. I have seen *centralis* from Loreto, Baja California; from Eldorado, Sinaloa, Santiago Esquintla, Veracruz, Cordoba, Tepic, Guadalajara, and Salina Cruz, Mexico; Tegucigalpa, Honduras; Granada and Chinandega, Nicaragua; and from Costa Rica (all at NMC). They are smaller than the representatives of the species from the United States, and somewhat more strongly and densely punctured. In view of this, I believe it expedient to retain *wickhami* as a subspecific name. The location of the elytral spot in *centralis* and *wickhami* is such that it is difficult to decide whether a discal or an apical spot is involved, although the former seems to me most probable.

HYPERASPIS CENTRALIS PLAGIATA, new subspecies

PLATE 3, FIGURE 82

Less convex than *wickhami*, the yellow margins of the pronotum in the male more strongly developed, elytra with a large red spot extending from two-fifths to four-fifths of the length and from the inner third to the outer sixth of the width, the outline somewhat uneven. Punctulation less strong than in *wickhami*. Genitalia unknown.

Length of the body, 2.8 mm.; width, 2.1 mm.

Type.—U.S.N.M. No. 54204.

Geographic distribution.—Locality as follows:

Maryland: 2.3 miles east of Piney Point (1 ♂, type, H. S. Barber, NMC).

Remarks.—Only a single male of this form is available. It differs from *wickhami* markedly both in body shape and in coloration and may prove to be a separate species.

***HYPERASPIS OCULIFERA* Casey**

PLATE 1, FIGURE 36

Hyperaspis oculifera CASEY, 1908, p. 415.

Differs from *centralis* and from *wickhami* by appreciably smaller body size, denser and stronger punctulation of the pronotum and the elytra, position of the spot, which is about equidistant from the suture and the external margin, and the shape of the head, which is relatively longer and narrower in *oculifera*. Male genitalia (pl. 4, fig. 112) resemble those of *wickhami*, except that size is smaller. The capsule of the spermatheca retort-shaped, the proximal portion small, with a very small appendix.

Length of the body, 2.1-2.5 mm.; width, 1.6-2.0 mm.

Geographic distribution.—Localities as follows:

Arizona: Benson (type CC, also Th. Dobzhansky collection), Santa Catalina Mountains, Tucson, Santa Rita Mountains, Huachuca Mountains (6,000 feet; D. J. and J. N. Knull, SC), Tubac (CASC), Nogales (CASC).

Remarks.—It is possible that *oculifera* will prove to be only a subspecies of *centralis*, although the differences between them appear to be rather considerable. The forms *oculifera-centralis-wickhami* may be arranged in a graded series with respect to size and punctulation.

***HYPERASPIS RIVULARIS*, new species**

PLATE 3, FIGURE 81

Broadly oval, strongly convex. Head yellow in males, black in females; pronotum in both sexes with subquadrate yellow spots laterally, the inner margin of the spots arcuate or straight, in males also with a yellow anterior margin. Elytra with a single yellow or orange discal spot, round or slightly transverse, in one individual (from southern Illinois) extended posteriorly as far as the apical fourth, the center of the spot lying distinctly in front of the middle of the length of the elytron, equidistant from the suture and the lateral margin. Punctulation of the upper surface dense but rather fine, that of the under side dense but stronger. Legs yellow with fuscous femora in both sexes, the abdomen dark piceous. Prosternal carinae as in *bicentralis*, femoral lines more evenly arcuate, not reaching the posterior margin. Genitalia unknown.

Length of the body, 2.2-3.0 mm.; width, 1.7-2.3 mm.

Type and five paratypes.—U.S.N.M. No. 54205.

Geographic distribution.—Localities as follows:

Kentucky: Frankfort (1 ♂, type, H. Soltau collection, now in NMC).

Illinois: southern part (1 ♀, 1 ♂, H. Soltau collection, now in NMC).

Missouri: St. Louis (3 ♀♀, H. Soltau collection, now in NMC).

Remarks.—This species is close to *bicentralis*, but its pronotal markings resemble more those of *centralis*. I believe *rivularis* is without doubt a separate species.

HYPERASPIS TUCKERI Casey

PLATE 1, FIGURE 12

Hyperaspis tuckeri CASEY, 1924, p. 162.

Oval, moderately convex. In the male head, mouth parts, and legs except the hind femora yellow, pronotum with a broad yellow stripe on the lateral and a narrow one on the anterior margin. Elytra with an orange-red spot on the disk, extending from basal fourth to apical third of the length, and from inner two-fifths to outer seventh of the width. Punctulation of the upper surface dense and fine, that of the under side very dense and rather strong. Genitalia unknown.

Length of the body, 2.8 mm.; width, 2.1 mm.

Geographic distribution.—Locality as follows:

Arizona: near Tucson (1 ♂, type, J. F. Tucker, CC).

Remarks.—I have seen only the type of this species. Casey's description of it is inaccurate in stating that the punctulation of the upper surface is "not close, very small and inconspicuous." Neither can I agree with Casey in placing this species as a relative of *connectens*, since it clearly belongs to the *binotata* group.

HYPERASPIS BIGEMINATA (Randall)

PLATE 3, FIGURE 84

Coccinella bigeminata RANDALL, 1838, p. 32.—MULSANT, 1850, p. 1050.—LECONTE, 1880, p. 188.—CASEY, 1899, p. 122.

Hyperaspis guexi MULSANT, 1850, p. 687.—LECONTE, 1880, p. 189.

Rounded oval, strongly convex. In males head, subquadrate spots on the lateral parts of the pronotum; and a narrow stripe on the anterior margin of the pronotum yellow; in females head black, pronotum with yellow spots laterally which are longer than wide and less often subquadrate. Elytra with a medium-sized, orange-red, rounded or slightly transverse apical spot located closer to the margin than to the suture. Punctulation throughout dense and strong, especially so on the sides of the metasternum and on the middle of the first abdominal sternite; the interstices on the head and the pronotum distinctly alutaceous, on the elytra polished. Tibiae and tarsi of all legs and parts of the femora of the front and middle ones yellow in males, only tarsi and tibiae pale in females. Prosternal carinae reaching far forward, femoral lines practically attaining the posterior

margin of the segment, their outer parts feebly or not at all angular. Paramera very short and broad, penis (pl. 4, fig. 119) very short, ax-shaped. Capsule of the spermatheca large, retort-shaped.

Length of the body, 2.9-3.2 mm.; width, 2.2-2.5 mm.

Geographic distribution.—Localities as follows:

Ontario: Scotia Junction (Wenzel, SC).

Maine: Summit of Mount Katahdin (NMC).

New Hampshire: White Mountains, Mount Washington.

New York: Top of Mount Whiteface, Mount Marcy, Adirondack, West Danby, Yaphank, Potsdam.

New Jersey: Lakehurst.

District of Columbia: Washington.

Virginia: Nelson County.

North Carolina: Southern Pines.

Georgia: St. Catherine Island.

Florida: Orange County, Fort Myers, Lakeland, Enterprise, Miami (on *Protoperiphrasie pyramidalis*).

Michigan: Whitefish Point, Marquette, Golden Ledge, Ann Arbor, Horn Mountain.

Indiana: Vigo County.

Texas: Beaumont (on *Eriococcus quercus*), Victoria, Cypress Mills, New Braunfels, College Station, Dallas, Fort Worth.

***HYPERASPIS GEMINA* Leconte**

PLATE 3, FIGURE 80

Hyperaspis gemina LECONTE, 1880, p. 188.

Broadly oval, moderately convex. Head yellow in both sexes, in females sometimes infuscate on the clypeus; pronotum black with a broad yellow margin laterally and a black anterior margin. Elytra with a transverse yellow apical spot, the spot constricted at about the middle of its width and showing a tendency to disintegrate into separate ones, an inner and an outer, of which the latter is smaller than the former. Punctulation of the head and the pronotum rather dense but fine, interstices delicately alutaceous, that of the elytra moderately strong with polished interstices, that of the under side dense and strong. Under side dark brown, mouth parts and legs brownish yellow, abdomen piceous brown. Prosternal carinae reaching to within a short distance from the anterior margin, femoral lines evenly rounded. Genitalia unknown.

Length of the body, 2.8-3.9 mm.; width, 2.1-3.1 mm.

Geographic distribution.—Localities as follows:

Virginia: Fortress Monroe (3 individuals, NMC).

North Carolina: Wenona (1 ♀, F. Sherman, NMC), Wilmington (3 individuals, W. T. Davis, C. W. Leng collection).

Remarks.—Leconte (1880) records this species for Georgia and Texas, from where I have seen no specimens. It seems to be rare and to have no close relatives; it is placed near *bigeminata* only provisionally.

HYPERASPIS UNIFORMIS Casey

PLATE I, FIGURE 14

Hyperaspis uniformis CASEY, 1924, p. 162.

Oblong oval, rather strongly convex, sides of the elytra weakly arcuate, broadly rounded posteriorly. In the male the head, mouth parts, prosternum, legs, and the abdomen except the middle testaceous, pronotum with a narrow yellow stripe on the anterior and with a much broader one on the lateral margins. Elytra solid black with a barely perceptible bluish luster. Punctulation of the upper surface, especially of the elytra, very fine and rather sparse, that of the under side denser but also rather fine. Genitalia unknown.

Length of the body, 3.0 mm.; width, 2.1 mm.

Geographic distribution.—Locality as follows:

North Carolina: Southern Pines (1 ♂, type, Manee, CC).

Remarks.—Two individuals belonging to different species stand in Casey's collection under the name "*uniformis*." The above description applies to the first of them, the type. The other is an undescribed species; the differences between the two are stated in Casey's paper (1924). It does not seem advisable at present to give a name to the second species. As to *uniformis* it seems best to place it in *binotata* group, although it is a rather aberrant form whose relationships could be determined only on basis of further material.

VII. POSTICA GROUP

Here belong several species living in the western United States. As a whole, this group is related to the preceding one. The elytral pattern consists of an apical spot, to which may be added a humeral one forming a rudimentary marginal vitta.

HYPERASPIS POSTICA Leconte

PLATE I, FIGURE 15

Hyperaspis postica LECONTE, 1880, p. 188.—CASEY, 1899, p. 127.

Oval, moderately convex. In males head yellow with a black fascia on the vertex frequently covered by the margin of the pronotum; in females head black. Pronotum in both sexes with a moderately broad

yellow stripe on the lateral margins. Elytra with a yellow apical spot lying much closer to the margin than to the suture, transversely oval or wedge-shaped, its outline well defined. Punctulation of the upper surface moderately dense but fine, interstices nonalutaceous, that of the under side denser and stronger, especially on the metasternum. In males legs brownish yellow, the abdomen brownish piceous; in females femora and tibiae dark brown, abdomen brownish black with piceous sides and tip. Prosternal carinae low, femoral lines almost reaching the posterior margin of the segment, running for a distance parallel to the latter, their outer parts angular. Penis (pl. 5, fig. 137) and the paramera very long and slender, the former as long as, or longer than, the latter, gradually narrowing distally, the tip hook-shaped. Female genitalia unknown.

Length of the body, 2.3-3.1 mm.; width, 1.7-2.2 mm.

Geographic distribution.—Localities as follows:

British Columbia: Kaslo (R. P. Currie, NMC), Vernon, Salmon Arm (H. B. Leach, SC), Nanaimo (E. P. Van Duzee, CASC).

Idaho: Cow Creek (6,400 feet; R. W. Haegele, University of Idaho collection).

Oregon: 14 miles East of Mitchell (3,750 feet; H. A. Scullen).

Utah: Ogden (NMC).

California: Weott, Humboldt County; Twin Rocks, Mendocino County; Carrville; Nash Mine, Trinity County; Siskiyou County; Cayton; McCloud; Castle Crag; Shasta Springs; Yreka; Oroville; Twain; Portola, Plumas County; Facht, Lassen County; Lyons Dam, Tuolumne County; Yosemite; Wawona; Big Bend Mountain; Pentz, Butte County; Placer County; Truckee; South Fork Kings River; Sequoia Park; Kaweah; Atwood Mill, Tulare County; Coleville, Mono County; Mount Tamalpais; Lagunitas; Fort Baker; Mill Valley; Milbrae; Sobre Vista, San Mateo County; Alameda; Redwood City; Santa Cruz; Carmel; Santa Barbara County; Mohawk; San Diego.

Arizona: Hualpai Mountains (D. J. and J. N. Knull, SC).

Remarks.—This species varies greatly in body shape as well as in size and shape of the apical spot, and may possibly prove to be a composite of several fairly distinct races. In particular, a series of individuals from Marin County, Calif. (SC), shows all degrees of the disappearance of the spot, and almost certainly represents a local race.

HYPERASPIS ELLIPTICA Casey

PLATE I, FIGURE 13

Hyperaspis elliptica CASEY, 1899, p. 126.

Hyperaspis elliptica angustula CASEY, 1899, p. 127.

Resembles *postica*, but body size larger, distinctly more elongate, punctulation of the elytra stronger. Under side very dark piceous,

tibiae and tarsi yellowish in males, brown in females. Femoral lines angular externally. Genitalia unknown.

Length of the body, 2.6-3.2 mm.; width, 1.6-2.0 mm.

Geographic distribution.—Localities as follows:

British Columbia: Kaslo (R. P. Currie, NMC).

Montana: Helena (NMC).

Washington: Easton (A. Koebele, NMC).

California: State record (type of *elliptica*, CC), Mendocino County (type of *angustula*, CC, also San Diego Museum collection), Huntington Lake (E. P. Van Duzee, CASC).

Remarks.—This species is closely related to *postica* but appears to be a separate type, despite the overlapping geographic distribution. Casey's *angustula* is merely an individual variant and may be treated as a synonym.

HYPERASPIS NUNENMACHERI Casey

PLATE 3, FIGURE 85

Hyperaspis nunenmacheri CASEY, 1908, p. 417.

Broadly oval, moderately convex. In males head yellow with a black fascia on the vertex, pronotum with a narrow yellow lateral margin produced along the anterior margin as far as the inner edge of the eye; in females head and pronotum black. Elytra with orange-yellow humeral and apical spots, the former extending from the humeral angles to one-sixth of the length of the outer margin, narrowing posteriorly; the latter rather small, transversely oval, located much closer to the margin than to the suture. Punctulation of the upper surface rather dense but moderately strong, interstices non-alutaceous, that of the under side stronger. Tibiae and tarsi, in males also parts of femora yellow. Prosternal carinae well developed, the space between them narrow, reaching far forward; femoral lines evenly arcuate. Penis (pl. 6, fig. 153) somewhat shorter than the paramera, of the same type as in *postica* but relatively much shorter and broader. Female genitalia unknown.

Length of the body, 2.7-3.3 mm.; width, 2.0-2.4 mm.

Geographic distribution.—Localities as follows:

Washington: State record (Morrison, NMC).

Oregon: Celestin (E. P. Van Duzee, CASC).

Idaho: Boise (NMC).

California: Marin County, Santa Clara County, San Mateo County, San Francisco (SC, CASC), Riverside (type, CC), Plumas County (C. W. Leng collection).

Remarks.—The two individuals from Washington and Idaho are less broadly oval than the California ones; they may belong to a separate race.

HYPERASPIS OCULATICAUDA Casey

PLATE I, FIGURE 18

Hyperaspis oculaticauda CASEY, 1899, p. 127.

Resembles *postica*, but is easily distinguishable from the latter owing to its small size. Oval, moderately convex. In males head yellow with a bisinuate black vitta on the vertex, black in females; pronotum in both sexes with rather narrow, well-defined yellow stripes on lateral margins. Elytra with a well-defined yellow apical spot, transversely oval or subquadrate in shape, located closer to the margin than to the suture. Punctulation of the pronotum dense and fine, interstices very delicately alutaceous, that of the elytra as dense but decidedly stronger, interstices nonalutaceous, that of the under side relatively fine, except on the sides of the metasternum where it is dense and strong. Under side brownish black, mouth parts and legs brownish, lighter in males than in females. Prosternal carinae strong, almost reaching the anterior margin, femoral lines angular externally, attaining the posterior margin of the segment. Genitalia unknown.

Length of the body, 1.8-2.2 mm.; width, 1.3-1.6 mm.

Geographic distribution.—Localities as follows:

Oregon: Celestin (E. P. Van Duzee, CASC), Klamath Falls (E. C. Van Dyke, CASC).

California: Hoop Valley; Trinity River (type CC); Yreka; Carrville; Trinity County; Siskiyou County; Cayton, Shasta County; Shasta Springs; Tallac; Lake Tahoe; South Fork Kings River; Placer County; Lassen County; Plumas County; Mendocino County; Lakeport; Sisson; Oroville; Cole; Milbrae; Lagunitas; Mount Tamalpais; Muir Woods; Brentwood; Fort Baker; San Francisco; Berkeley; Alameda; Pacific Grove; Carmel; Santa Cruz County; Los Angeles County; Bishop.

Nevada: Carson City (J. N. Knull, SC), Reno (large series, F. E. Blaisdell, CASC).

HYPERASPIS EFFETA Casey

PLATE I, FIGURE 11

Hyperaspis effeta CASEY, 1899, p. 127.

Very similar to *oculaticauda*, differs principally in having the apical spot much smaller, rounded or slightly transversely oval, with suffused boundaries. The general pigmentation tends toward brown instead of black, in apparently mature individuals elytra as well as the pronotum piceous, under side from dark to light piceous brown. Punctulation of

the upper surface finer, there being less difference between the punctures on the elytra and on the pronotum in *effeta* than there is in *oculaticauda*. Genitalia unknown.

Length of the body, 1.8-1.9 mm.; width, 1.3-1.4 mm.

Geographic distribution.—Localities as follows:

Oregon: Klamath Falls (1 ♀, E. C. Van Dyke, CASC).

California: Placer County (1 ♂, type, CC, 1 ♀, A. Koebele, NMC); Lake Tahoe (1 ♂, NMC); Cayton, Shasta County (1 ♀, E. P. Van Duzee, CASC); Glen Alpine (1 ♀, CASC).

Remarks.—*H. effeta* and *oculaticauda* are so similar that the distinction between them may perhaps be questioned. The few specimens that I have seen appear to have slight but consistent differences in their habitus, which, together with their overlapping distribution, make me believe that they represent distinct species.

HYPERASPIS SUBDEPRESSA Casey

PLATE I, FIGURE 16

Hyperaspis subdepressa CASEY, 1899, p. 127.

Elliptical, subdepressed. In males head yellow with a transverse black fascia on the vertex, in females head black; pronotum in both sexes with a yellow lateral margin, the inner boundary of the yellow vitta nubilate. Elytra with a yellow humeral spot and a small nubilate yellow apical one. Punctulation rather dense and strong, interstices not alutaceous. In females the under side piceous, in males mouth parts and legs, except the hind femora, grayish yellow. Genitalia unknown.

Length of the body, 2.1-2.3 mm.; width, 1.4-1.6 mm.

Geographic distribution.—Localities as follows:

California: Alameda County (1 ♀, type, CC, 1 ♂, A. Koebele, NMC), Dixon (1 ♂, E. P. Van Duzee, CASC), Paraiso Hot Springs (1 ♀, L. S. Slevin, CASC).

Remarks.—Casey's type is a single badly preserved female which may represent an incompletely hardened specimen. The other specimens which I have seen differ from the type in being less narrowly elliptical, in having larger humeral spots, and the apical spots less nubilate in outline. This species seems to be close to *effeta*, but on the other hand to have a resemblance to *dissoluta* from which it differs by its small size.

VIII. TAENIATA GROUP

Here belong several species inhabiting western and southern United States, some of which are so variable and so highly differentiated geographically that they were quite needlessly split into numerous specific

units, which in reality are only geographic races or even nongeographic variants. The elytral pattern is very diversified; the marginal spot is present in most species, frequently alone. It may, however, become fused with the humeral one forming a marginal vitta; discal and apical spots may also be present and fused with the marginal one, making the background of the elytra pale instead of black. Penis and the paramera usually rather elongate, the former tongue-shaped. Capsule of the spermatheca retortlike, the connecting duct long.

HYPERASPIS TAENIATA TAENIATA Leconte

PLATE I, FIGURE 20

Hyperaspis taeniata LECONTE, 1852, p. 134; 1880, p. 187.—CASEY, 1899, p. 125.

Rather broadly oval, moderately convex, somewhat obtusely rounded behind. In males head yellow with a bisinuate black stripe on the vertex, pronotum with a narrow yellow stripe on lateral margins which in most individuals is produced for a varying distance on the anterior margin; in females head and pronotum black. Elytra with an orange-yellow or yellow marginal vitta beginning at the humeral angles, extending past the middle of the length of the external margin, and strongly expanded inward in its posterior part; the expanded part of the vitta very irregular in outline and variable in extent but always reaching to the inner half of the width of the elytron (the expanded part of the vitta obviously represents a fusion of the marginal vitta with a discal spot). Pronotum and the elytra almost equally finely and moderately densely punctulate, punctulation of the under side denser but fine, except on the prosternum and the sides of the metasternum where it is denser and coarser. Under side dark piceous or black, in males mouth parts, front legs, tibiae and tarsi of the middle and hind legs yellow, in females tibiae and tarsi yellow brown. Prosternal carinae well developed, fused together in front of the middle of the length of the segment, femoral lines running for a distance parallel to the hind margin of the first sternite, their outer parts angular. Penis (pl. 6, fig. 156) somewhat shorter than the paramera, the latter slender, basal plates short. Basal portion of the spermatheca short and broad, appendix rather small.

Length of the body, 2.2-3.0 mm.; width, 1.7-2.2 mm.

Geographic distribution.—Localities as follows:

California: Los Angeles County (Coquillett, NMC, F. T. Scott, SC, CASC), Redondo Beach, San Diego, Poway, Pasadena, Palm Springs, Santa Barbara County (P. H. Timberlake collection, CASC), San Bernardino, Mojave (F. T. Scott, SC), Kern County (SC), Tulare County (F. T. Scott, SC), see also under *significans*.

Utah: Logan (F. Marlatt, NMC).

HYPERASPIS TAENIATA NEVADICA Casey

Hyperaspis nevadica CASEY, 1899, p. 125.

Less broadly oval than the typical *taeniata*, the yellow vittae on the pronotum in males not produced along the anterior margin, the marginal vitta of the elytra yellow, gradually expanded caudad, its maximum width less than one-third of that of the elytron, the interior outline smooth and clearly defined, punctulation of the upper surface somewhat finer. Mesosternal epimera in the male white. Femoral lines more evenly arcuate, their parts running parallel to the posterior margin of the segment very short. Genitalia as in the typical form.

Length of the body, 2.3-3.0 mm.; width, 1.7-2.1 mm.

Geographic distribution.—Localities as follows:

Idaho: Twin Falls, Filer, Burley, Tuttle, Hansen, Hubbs Butte, Bliss, Boise, Hagerman, Murtaugh, Paul, Declo, Castleford, Hammett, Buhl, Gooding, Hollister, Wendell, Oakley.

Oregon: Harvey County, Hermiston.

Utah: American Fork Canyon (NMC), Salt Lake City (CASC).

Nevada: Reno (type, CC), Elko, Carson City, Lovelock.

Arizona: Pima Mountains (NMC), Hualpai Mountains (SC).

California: Bishop (CASC), Independence (CASC), Mount Wilson (CASC).

Remarks.—This is a well-marked subspecies. Individuals from Arizona, however, have the marginal vitta on the elytra more rapidly expanding caudad, constituting a transition to subspecies *significans*. No intermediates between *nevadica* and the typical *taeniata* have been seen, however; it is possible that their distribution ranges are separated by the Sierra Nevada Mountains, where the species does not occur.

HYPERASPIS TAENIATA PERPALLIDA, new variety

PLATE I, FIGURE 21

Pronotum in the female with a broad yellow vitta on the lateral margins, not produced along the anterior margin; head black. Elytra yellow, rimmed with black, the black part very narrow on the external margin, somewhat expanding caudad, forming a broad sinuate sutural vitta, and a still broader basal one sharply constricted at the humeral angles. Coloration of the under side in the female like that in the male of the typical form. Male unknown. Genitalia unknown.

Length of the body, 2.7 mm.; width, 1.9 mm.

Type.—U.S.N.M. No. 54206.

Geographic distribution.—Localities as follows:

California: Sacramento County, Grand Island (1 ♀, type, SC, now in NMC).

Remarks.—This is a variant with extremely lightly colored elytra, in which, in addition, the under side of the female assumes the pigmentation found in the male of the type form. Its exact status cannot be established since only a single specimen is available: it may prove to be a subspecies or a nongeographic form.

***HYPERASPIS TAENIATA PALLIDULA*, new variety**

Differs from the typical *taeniata* by a greatly expanded marginal vitta, and by the presence of a rather large, transversely oval apical spot, showing a tendency toward confluence with the vitta. Mesosternal epimerae yellow in the male. Genitalia unknown.

Length of the body, 2.6-2.8 mm; width, 1.8-2.0 mm.

Type.—In collection of F. T. Scott.

Paratype.—U.S.N.M. No. 54207.

Geographic distribution.—Locality as follows:

California: Kern County (1 ♂, type, and 1 ♀, F. T. Scott, SC).

Remarks.—This form is intermediate between variety *perpallida* and *taeniata taeniata*. F. T. Scott's collection contains two individuals of the latter form from Kern County in which the marginal vittae are strongly expanded but which have no trace of apical spots. It appears, then, that *pallidula* is a geographically restricted individual variation. If *perpallida* proves to be a subspecies, the population containing *pallidula* should be classified as another subspecies bridging the gap between *taeniata taeniata* and *taeniata perpallida*.

***HYPERASPIS TAENIATA SIGNIFICANS* Casey**

PLATE I, FIGURE 24

Hyperaspis significans CASEY, 1908, p. 416.

Differs from the typical form chiefly in coloration. In males head reddish yellow, rather gradually darkening toward the vertex which is black; pronotum with a dull red ill-defined vitta on the lateral margins; in females head brown, becoming black toward the vertex, pronotum solid black or black with a suffused reddish streak in the anterior angles and along the lateral margins. Elytra with a variable orange or red marginal spot extending from one-quarter to three-fifths of the length and from the margin to the middle of the width of the elytron, frequently extended cephalad along the margin to form a marginal vitta; the inner outline of the spot or the vitta is suffused brownish. Punctulation of the upper surface as a rule somewhat denser, finer, and deeper than in the typical form. Under side varying from reddish brown to black. Genitalia similar to those of the typical

form, except that the penis (pl. 6, fig. 159) is somewhat shorter and broader.

Length of the body, 2.2-2.5 mm.; width, 1.7-1.9 mm.

Geographic distribution.—Localities as follows:

California: Los Angeles County, Covina, Claremont, Verdement Cajon Pass, San Diego County (taken on *Opuntia* infested by cochineal scale, F. T. Scott), Coachella Valley (A. P. Dodd, on cochineal and on *Dactylopius tomentosus*, NMC).

Utah: St. George (type, CC, also in C. W. Leng collection).

Arizona: Bright Angel (E. W. Nelson, on *Dactylopius confusus*, NMC), Prescott (NMC).

Remarks.—In the Southwest this subspecies merges into the typical *taeniata*; thus, the specimens from Covina, Calif., have elytral markings yellow instead of red, the head in females and the under side black, the vitta on the pronotum yellow and rather sharply defined instead of suffused. In general, the specimens from Los Angeles County might be classified as belonging to *taeniata taeniata* as well as to *taeniata significans*. Specimens from St. George, Utah, to which the type belongs, range rather toward *nevadica*. The purest representatives of *significans* which I have seen occur in the Coachella Valley, Calif., where the species appears to be very common. Casey (1908) believed *significans* to be related to *pleuralis*, which is certainly not the case.

HYPERASPIS TAENIATA variety CONCURRENS Casey

Hyperaspis concurrens CASEY, 1908, p. 416.

Differs from *taeniata significans* in the absence of the spot on the elytron, making the latter completely black. Genitalia identical.

Geographic distribution.—Locality as follows:

Utah: St. George (3 individuals, including the type, in CC, and a large series in NMC).

Remarks.—This appears to be a geographically restricted color variant so far recorded only from Utah. Intermediates between *concurrens* and *significans* are rare or absent despite the fact that they occur together. This indicates that the difference between them is due to a single gene.

HYPERASPIS TAENIATA PALLESCENS, new variety

PLATE I, FIGURE 23

Body shape, size, and structural characters as in *taeniata nevadica*. Elytra with a marginal vitta reaching to the apical region, greatly expanded inward in the discal region, the expanded part reaching the inner half of the width of the elytron. Genitalia unknown.

Type.—In collection of F. T. Scott.

Paratype.—U.S.N.M. No. 54208.

Geographic distribution.—Locality as follows:

Arizona: Hualpai Mountains (3 ♀♀ including the type, D. J. and J. N. Knull, SC).

Remarks.—This is a derivative from *taeniata nevadica* which is analogous to the derivative from *taeniata taemata* which is called above variety *pallidula*. F. T. Scott's collection has two more individuals from Hualpai Mountains, which I classify as belonging to *taeniata nevadica*, although these individuals, as well as those of variety *pallidula* show an admixture of the characteristics of *taeniata significans*. Variety *pallidula* is, then, probably a geographically restricted color variant.

HYPERASPIS TAENIATA RUFESCENS, new subspecies

PLATE I, FIGURE 25

Resembles most closely *taeniata significans*, but head yellow with a black vitta on the vertex in males, black becoming brownish on the clypeus in females. Pronotum with a suffused orange-yellow vitta on the lateral margins in males, black in females. Elytra with a rufous area extending from the margin to the middle of the width of the elytron, and from one-fifth to well past the middle of the length, in some individuals produced toward the humeral angles to form a marginal vitta, the outline of the area suffused internally. Color of the under side ranging from reddish brown to black. Punctulation of the elytra dense and distinctly finer than in *taeniata significans*. Genitalia identical.

Length of the body, 2.3-2.8 mm.; width, 1.7-2.1 mm.

Type and 10 paratypes.—U.S.N.M. No. 54209.

Geographic distribution.—Localities as follows:

Texas: El Paso (type, on *Opuntia*, F. C. Pratt, NMC), Brewster County (on *Coccus* on *Opuntia*, Mitchell and Cushman, NMC), Devil's River (F. C. Pratt, NMC).

New Mexico: Mesilla Park (on *Coccus confusus*, D. Griffiths, NMC).

Colorado: Palisade (W. A. Shands, NMC).

Remarks.—Certain individuals of *taeniata rufescens* are almost identical with individuals of *taeniata significans* from California, except that the punctulation in the former seems to be always finer than in the latter. Despite the closeness of the two, I believe *rufescens* to be worthy of recognition as a subspecies. Not only are the modal points of these two races different, but their geographic areas seem to be separated by a southward extension of the area of *taeniata nevadica*.

HYPERASPIS TAENIATA CRUENTA Leconte

PLATE I, FIGURE 26

Hyperaspis cruenta LECONTE, 1880, p. 187.

More broadly oval than the preceding races of *taeniata*, sides of the elytra less arcuate, more broadly rounded behind. In males head yellow with a black vertex, pronotum with a well-defined, yellow, parallel-sized, rather broad vitta on lateral margins, and a much narrower one on the anterior margins; in females head and the pronotum black. Elytra with a sharply defined yellow marginal vitta extending from the humeral angles to three-fifths of the length; the vitta somewhat expanded posteriorly and constricted at one-sixth of the length by a triangular projection of the black background. Punctulation dense but very fine, that of the pronotum clearly denser than that of the elytra. Under side black or piceous black, in males mouth parts and legs except the hind femora yellow, mesosternal epimera white; in females legs dark brown. Femoral lines run for a certain distance parallel to the posterior margin of the segment. Genitalia as in the typical form, except that the penis (pl. 6, fig. 154) is somewhat narrower and more acuminate toward the distal end.

Length of the body, 2.2-2.8 mm.; width, 1.6-2.1 mm.

Geographic distribution.—Localities as follows:

Texas: Brownsville, Esperanza Ranch (NMC), Columbus (NMC), Goliad (NMC), Uvalde.

Remarks.—This is the most distinctive one among the races of *taeniata*. Perhaps since no representatives of the species are known from central Texas or from northeastern Mexico, no intermediates between *cruenta* and *rufescens* have been observed. I include *cruenta* among the races of *taeniata*, although, admittedly, this course is open to question since the two may prove to be independent species.

HYPERASPIS TAENIATA CRUENTOIDES, new subspecies

PLATE I, FIGURE 27

Differs from *taeniata cruenta* in having an orange-red marginal vitta on the elytra, the width of the vitta uniform throughout its length or barely greater in its posterior part than at the humeral angles, without, or with merely an indication of, a constriction at the callus. Punctulation of the elytra extremely fine, almost obsolescent on the disk. The shape of the penis intermediate between those in the typical *taeniata* and in *taeniata cruenta*, being closer to the former than to the latter.

Length of the body, 2.7-3.2 mm.; width, 2.1-2.4 mm.

Type and two paratypes.—U.S.N.M. No. 54210.

Geographic distribution.—Locality as follows:

Florida: Bartow Junction (1 ♂, 2 ♀♀, collection of Hubbard and Schwarz, now in NMC).

Remarks.—In certain characters (e.g., punctulation) *cruentoides* differs from the western races of *taeniata* even more than *cruenta* does, yet in others (coloration) it is intermediate between them, thus making *cruenta* less isolated.

HYPERASPIS TAENIATA BINARIA Casey

PLATE I, FIGURE 30

Hyperaspis binaria CASEY, 1924, p. 165.

Body shape as in *taeniata cruenta* and *cruentoides*. In females head, pronotum, and the under side black, tibiae, tarsi, and sides of the abdominal segments piceous; male unknown. Elytra with an abbreviated dull orange marginal vitta beginning at about one-fifth of the length of the external margin, expanding caudada, and somewhat deflected from the margin in its posterior part; the boundaries of the vitta rather nubilate. Punctulation dense and fine, although somewhat stronger than in *cruentoides*, pronotum feebly alutaceous. Genitalia unknown.

Length of the body, 2.3-2.8 mm.; width, 1.8-2 mm.

Geographic distribution.—Localities as follows:

North Carolina: Southern Pines (1 ♀, type, CC).

Florida: Fort Walton (1 ♀, Geo. Swank, NMC).

Remarks.—This is the easternmost representative of the *taeniata* complex. The material available on *binaria* as well as *cruentoides* being as scarce as it is, the failure to observe intermediates between them is not surprising, but this fact does not seem to me sufficient ground to classify them as independent species. Taken as a whole, the *taeniata* complex is an extremely interesting one. The various subspecies show various recombinations of several characters (color of the elytral markings, their reduction or expansion, punctulation, etc.); certain combinations have become geographically established, others still occur in mixed populations only, and have been classed above as varieties rather than subspecies.

HYPERASPIS OSCULANS Leconte

PLATE I, FIGURE 29

Hyperaspis osculans LECONTE, 1880, p. 187.—CASEY, 1899, p. 125.

Broadly oval, rather obtusely rounded behind, moderately convex. In males head pale yellow with a black stripe on the vertex, pronotum

with a pale yellow vitta laterally expanding anteriorly and as a whole forming a triangular spot; in females head black, pronotum black, or black with a pale streak in anterior angles, or with a pale vitta on lateral margins which is, however, not as broad as in males. Elytra with a marginal spot varying in color from yellowish white to orange yellow, the spot wider than long, reaching inward to from one-quarter to almost one-half of the width of the elytron. Punctulation dense and fine, that of the elytra only slightly stronger than that of the pronotum. Mouth parts, tibiae, tarsi, and tips of femora yellow in males, brown in females; abdomen sometimes piceous on sides. Prosternal carinae strong, in some individuals almost reaching the anterior margin; femoral lines arcuate, just touching the posterior margin, their outer parts not angular. Paramera (pl. 6, fig. 160) short and broad, almost spoon-shaped, penis somewhat shorter than the paramera, very asymmetrical, one side nearly straight while the other forms a large triangular process, the distal end rather rounded. Female genitalia unknown.

Length of the body, 2.5-3.1 mm.; width, 2.0-2.4 mm.

Geographic distribution.—Localities as follows:

California: Cayton, Shasta County; Eldridge, Sonoma County; Santa Clara County; Eldorado County; Camino; Colfax; Ahwahnee; Sequoia Park; Potwisha; Kaweah; Santa Barbara County; Lebec; Mount Lowe; Pasadena; Forest Home; Claremont (SC).

HYPERASPIS PLEURALIS Casey

PLATE I, FIGURE 28

Hyperaspis pleuralis CASEY, 1899, p. 125.

Broadly oval, rather obtusely rounded behind, moderately convex. In males head yellow with a black stripe on the vertex, pronotum with a yellow lateral margin which is distinctly narrower than in *osculans* but which is, in some individuals, produced for a short distance along the anterior margin; in females head and the pronotum black. Elytra with a marginal spot varying in color from yellow to dull red, semi-circular in form, reaching inward to no more than a quarter of the width of the elytron. Punctulation dense and rather strong, much denser on the pronotum than on the elytra. Mouth parts and front legs brownish yellow, middle and hind legs brown in males, in females tarsi dark brown. Prosternal carinae variable, but generally reaching forward to only the middle of the length of the segment; femoral lines as in *osculans*. Paramera (pl. 6, fig. 161) slender, penis relatively very broad, only slightly narrowing distally, the distal end rounded, one side nearly straight and the other with an obtuse process located

relatively very close to the base. The capsule of the spermatheca retort-shaped, basal portion with a rather large appendix.

Length of the body, 2.1-2.5 mm.; width, 1.6-2.0 mm.

Geographic distribution.—Localities as follows:

Texas: Finlay (J. O. Martin, CASC), El Paso (type, CC), 20 miles east of El Paso (Th. Dobzhansky).

Arizona: Tucson, Pima Mountains, Santa Rita Mountains, Littlefield, Oracle, Williams, Hot Springs, Ajo, Tonto Basin, Yuma

California: Truckee, Lebec, Los Angeles County, Monrovia (on *Dactylopius confusus*), Upland, San Bernardino, San Diego County, Grapevine Grade, Kern County, Olancho, Little Lake, Mojave, Panamint Valley, Palm Springs.

Utah: St. George, Salt Lake City (P. H. Timberlake collection, CASC).

Nevada: Glendale.

Remarks.—Individuals of this species from California have larger and yellower spots than those from Arizona and Texas, thus indicating a transition toward *osculans*. No doubt, *osculans* and *pleuralis* are very closely related, but their distribution areas definitely overlap in California, without, however, real intergrades being formed. This fact, as well as the rather considerable morphological differences between them, indicate that they are to be considered separate species rather than races of a single one.

HYPERASPIS PLEURALIS variety ATERRIMA Casey

Hyperaspis aterrima CASEY, 1908, p. 416.

Differs from the typical *pleuralis* in having solid black elytra and in having both the lateral and the anterior margins of the pronotum yellow in males. Genitalia of both sexes identical with those of *pleuralis*, as is the body size.

Geographic distribution.—Localities as follows:

Texas: El Paso, Finlay.

Arizona: Hot Springs, Tucson, Phoenix, Yuma.

California: Los Banos, Fresno County, Tulare County (on *Atriplex* infested by a cottony scale, F. T. Scott), Poso Creek, Kern County, Death Valley, Blythe, Imperial County, Palm Springs, San Diego County.

Utah: St. George (type, CC, also a series of specimens in NMC).

Nevada: Overton.

Mexico: Sonora (Koebele, NMC).

Remarks.—The taxonomic status of *aterrima* is a rather perplexing problem. It differs from the typical *pleuralis* in two apparently distinct characters, namely, absence of the elytral spot and presence of a yellow anterior margin of the pronotum in males. These characters show a strong, although not perfect, correlation (there is one male from Hot Springs, Ariz., having black elytra and a black anterior margin of the

pronotum). Since, in Coccinellidae, the color patterns of the pronotum and of the elytra are, as a rule, inherited independently, such a correlation would be understandable if *pleuralis pleuralis* and *pleuralis aterrima* were geographically isolated. As a matter of fact, their distributions are nearly identical, and in many localities both are found side by side, although their proportions in different populations are by no means identical. Thus, a fairly large sample from Blythe, Calif. (P. H. Timberlake collection), contains only *aterrima*, whereas east of El Paso, Tex., I have collected more than 100 *pleuralis* and no *aterrima*. Under such circumstances we may be dealing either with color forms differing in one gene, or with independent species. A careful morphological comparison has been undertaken, without any additional difference being detected. This is a very interesting case showing the limitations of a purely morphological method of investigation. The status of *aterrima* could be settled only on the basis of experimental data, which are lacking at present.

HYPERASPIS BIORNATA BIORNATA Nunenmacher

PLATE 2, FIGURE 71

Hyperaspis biornatus NUNENMACHER, 1934, p. 18.

Broadly oval, obtusely rounded behind, little convex, pronotum short but wide. In males head yellow with a black stripe on the vertex, pronotum with yellow vittae on the lateral margins very slightly or not at all produced along the anterior margin, the length of the vittae being about twice as great as their maximum width, which is attained near the anterior angles; in females head black, pronotum with yellow vittae laterally which are about three times longer than wide. Elytra with yellow marginal and apical spots, the former located slightly behind the middle of the length of the elytron, almost detached from the margin, rounded or transverse, reaching inward to from one-third to one-half of the width, the apical spots much smaller, obliquely oval, and usually connected with the marginal ones by yellow bridges of varying width. Punctulation of the pronotum rather dense and medium fine, that of the elytra only slightly stronger but not sparser than that of the pronotum, that of the under side very dense and moderately strong. Mouth parts, front legs, tibiae and tarsi of the middle and hind legs brownish yellow in males, tibiae and tarsi piceous in females. Prosternal carinae reaching forward to between two-thirds and three-quarters of the length of the segment, femoral lines arcuate, not touching the posterior margin of the first abdominal ster-

nite. Genitalia very similar to those of *osculans*, except that the penis is much shorter than the paramera.

Length of the body, 2.6-3.0 mm.; width, 2.0-2.3 mm.

Geographic distribution.—Localities as follows:

California: Monterey County (2 ♂♂, 1 ♀, F. T. Scott, SC), Stanford University (1 ♀, G. F. Ferris, NMC), Pinnacles National Monument (1 ♀, 1 ♂, Th Dobzhansky), Big Sur (1 ♀, CASC), described from Livermore, Alameda County (type not examined by the writer).

Remarks.—In his description, Nunenmacher compares this species with *connectens* (*lengi*), with which it has only a most superficial similarity; *biornata* certainly belongs to the *taeniata* group and is closely related to *osculans*, although it represents undoubtedly a distinct species. The marginal spot in *biornata* lies farther caudad than in its relatives, which is probably due to a change in body shape.

HYPERASPIS BIORNATA ARIZONICA, new subspecies

PLATE 2, FIGURE 61

Body more elongate than in the typical *biornata*, less obtusely rounded behind. Coloration of the head as in *biornata*. Pronotum in the male with a yellow stripe laterally which is more than twice as long as wide, not produced on the anterior margin, in females with a yellow streak laterally which either resembles that in *biornata* or is reduced to the extent that it does not reach either the anterior or the posterior angles. Elytra with a large orange-yellow spot on the external margin extending from three-fifths to seven-eighths of the length, obliquely cut anteriorly and posteriorly, its inner boundary parallel to its outer one, reaching inward to and beyond the middle of the width of the elytron. Punctulation of the pronotum noticeably denser and finer than that of the elytra. Shape of the femoral line unique, compressed from sides, parabola-shaped. Genitalia unknown.

Length of the body, 2.3-3.0 mm.; width, 1.7-2.2 mm.

Type and three paratypes.—U.S.N.M. No. 54211.

Geographic distribution.—Locality as follows:

Arizona: Bright Angel (3 ♀♀, 1 ♂, Barber and Schwarz, NMC).

Remarks.—Despite rather considerable differences between *biornata* *biornata* and *biornata arizonica* (especially the difference in the shape of the femoral line), I believe them to be races of the same species. The elytral spot in *arizonica* corresponds to enlarged and fused marginal and apical spots of the typical *biornata*.

IX. FIMBRIOLATA GROUP

This group consists of a series of rather closely related forms some of which appear to stand on the very threshold between being races of the same species and independent species. Body oval, moderately convex. Elytra with a yellow or red marginal vitta extending from the humeral angles to within a short distance from the apex; the vitta represents fused humeral, marginal, and apical spots, and in some species breaks up into these constituent parts. Penis about as long as the paramera, acuminate distally, paramera slender, fingerlike, basal plates small. The capsule of the spermatheca retort-shaped, basal portion short but rather broad, with a moderately small appendix.

HYPERASPIS FIMBRIOLATA FIMBRIOLATA Melsheimer

PLATE 3, FIGURE 86

Hyperaspis fimbriolata MELSHEIMER, 1847, p. 180.—LECONTE, 1880, p. 186.—CASEY, 1899, p. 126.

Hyperaspis rufomarginata MULSANT, 1850, p. 661.—LECONTE, 1880, p. 189.

Hyperaspis limbalis CASEY, 1899, p. 126.

Oval, moderately convex. In males head yellow with a black stripe on the vertex covered by the margin of the pronotum, pronotum with a yellow vitta on the lateral margins slightly produced on the anterior margin, the vitta narrow, becoming somewhat broader anteriorly; in females head and pronotum black. Elytra with a yellow or orange marginal vitta which is one-fourth or one-fifth as wide as the elytron, clearly bisinuate, the apical end deflected from the margin but not increased greatly in width, not protracted forward, evenly rounded. Punctulation of the pronotum dense and moderately strong, that of the elytra somewhat less dense and a little stronger, that of the under side dense but rather strong. Legs black, tibiae and tarsi brownish in females, yellowish in males. Prosternal carinae reaching forward to about two-thirds of the length of the segment, femoral lines broad, their middle parts subparallel to the posterior margin of the first abdominal sternite. Penis (pl. 5, fig. 144) long, concave on one side and convex on the other. The proximal part of the spermatheca one and one-half times longer than wide, appendix relatively large.

Length of the body, 2.3-2.8 mm.; width, 1.7-2.0 mm.

Geographic distribution.—Localities as follows:

New York: Rockaway, Pelham.

New Jersey: Emerson.

Maryland: Baltimore.

District of Columbia: Washington.

Virginia: Fortress Monroe.

North Carolina: Black Mountains.

Illinois: Havana, Ashley, Du Bois.

Nebraska: Lincoln.

Kansas: Topeka, West Kansas.

Texas: College Station Chisos Mountains, Brewster County, Marathon, Thurber, Devil's River, Dallas, Rosser, Laredo, Beeville, Mission, Austin, Uvalde, Gorman, Davis Mountains, Alpine, El Paso.

Colorado: Denver, Pueblo, Florence, Colorado Springs, Palisade, Salida.

New Mexico: Las Vegas, Torrance County, Fort Wingate.

Arizona: Chiricahua Mountains, Huachuca Mountains, Santa Rita Mountains, Nogales, Pinal Mountains, Palmerly, Oracle, Hot Springs, Williams, Globe.

California: Visalia, Riverside (on *Phenococcus colemani*), Selma, Santa Monica, Long Beach, Azusa, Warner's Hot Springs, San Diego, Playa del Rey.

***HYPERASPIS FIMBRIOLATA ATLANTICA*, new subspecies**

PLATE 3, FIGURE 91

More oval than *fimbriolata fimbriolata*, slightly acuminate posteriorly. Punctulation much finer, the interstices between the punctures alutaceous. The marginal vitta ochraceous, narrower than in the typical form, its internal boundary not bisinuate, evenly curved, its width gradually but slightly increasing toward the apex, the apical part only very slightly deflected from the margin, not at all protracted forward. Tibiae and tarsi of all legs brownish yellow, hind tibiae infusate. Penis (pl. 5, fig. 141) narrower than in the typical form.

Length of the body, 2.3-2.7 mm.; width, 1.6-1.9 mm.

Type and three paratypes.—U.S.N.M. No. 54212.

Geographic distribution.—Localities as follows:

Florida: Capron (type, collection Hubbard and Schwarz, now in NMC), Crescent City (NMC).

Virginia: Fortress Monroe (NMC).

Mississippi: Waveland (H. Soltan collection, now in NMC).

***HYPERASPIS FIMBRIOLATA SERENA* Casey**

PLATE 3, FIGURE 89

Hyperaspis serena CASEY, 1908, p. 417.

Intermediate between *fimbriolata fimbriolata* and *fimbriolata inflexa*. More oblong than the former but not acuminate posteriorly. Punctulation fairly strong, interstices polished. Anterior margin of the pronotum yellow in males. Marginal vitta broad, its apical end dilated, truncate instead of rounded, slightly protracted forward. Genitalia as in *inflexa*.

Length of the body, 2.4-2.5 mm.; width, 1.7-1.8 mm.

Geographic distribution.—Localities as follows:

Massachusetts: Springfield, Tyngsboro.

New York: Whiteface Mountains, Palisades, Van Cortland Park, Westchester County, Moshulu, Babylon, Long Beach, Yaphank.

New Jersey: Lakhurst, Longport, Jamesburg.

Pennsylvania: State record (type, CC).

Michigan: Marquette, Douglas (NMC).

Remarks.—This is a slight race of *fimbriolata*, as stated above intermediate between the typical form and *inflexa*.

HYPERASPIS FIMBRIOLATA INFLEXA Casey

PLATE 3, FIGURE 87

Hyperaspis inflexa CASEY, 1899, p. 126.

Larger and more oblong than the typical form, not acuminate posteriorly. Anterior margin of the pronotum narrowly yellow in males. Marginal vitta broad, its width about equal to one-fourth of that of the elytron, its interior outline strongly sinuate, the apical end usually not deflected from the margin, strongly expanded, abruptly truncate, and extended forward. Tibiae and tarsi pale. Penis (pl. 5, fig. 140) shorter than the paramera, gradually narrowing from the base distally, the tip rounded.

Length of the body, 2.6-2.9 mm.; width, 1.7-1.9 mm.

Geographic distribution.—Localities as follows:

Minnesota: Grand Marais, Cook County, Niswa, St. Paul, St. Anthony (all in University of Minnesota collection).

Manitoba: Andover (C. V. Riley collection, now in NMC), Aweme (C. W. Leng collection).

North Dakota: Bismarck (type, CC).

Montana: Helena, Bear Paw Mountains (NMC).

Nebraska: Pine Ridge.

Wyoming: Laramie (D. J. and J. N. Knull, SC).

Kansas: Riley County (NMC).

Colorado: Colorado Springs (NMC).

New Mexico: Magdalena (Strickler, NMC).

Remarks.—The individual from New Mexico is intermediate between *inflexa* and the typical form. The rather abundant material from Minnesota might be classed as belonging either to *inflexa* or to *serena*.

HYPERASPIS CINCTA Leconte

PLATE 3, FIGURE 90

Hyperaspis cincta LECONTE, 1858, p. 89; 1880, p. 189.—CASEY, 1899, p. 126.

Hyperaspis nupta CASEY, 1899, p. 126.

Broadly oval, moderately convex. In males head yellow, pronotum with a yellow vitta laterally becoming distinctly broader toward the anterior angles, and with the anterior margin narrowly yellow; in females head and pronotum black. The marginal vitta on the elytra orange, yellow, or cream-colored, very broad, its width equaling one-

third to more than one-half of the width of the elytron, sharply indented at the callus, and less sharply so at three-quarters of the length, the apical part not dilated, rounded at the tip. Punctulation of the pronotum moderately dense and medium strong, that of the elytra very sparse and fine, in some individuals almost obsolescent, that of the under side rather dense and strong. Mouth parts and legs pale, hind femora usually infusate, abdomen wholly or partly brownish. Prosternal carinae and femoral lines as in *fimbriolata*. Penis (pl. 5, fig. 139) and the paramera shorter than in *fimbriolata*, tip of the former acuminate. Female genitalia as in *fimbriolata*.

Length of the body, 1.9-2.5 mm.; width, 1.4-1.9 mm.

Geographic distribution.—Localities as follows:

California: Humboldt County (type of *nupta*, CC); Mendota, Fresno County; Selma; Los Banos, El Cajon, Claremont, Mount San Geronio; Visalia (a large series reared from *Sueda torreyana* infested by a psyllid, *Aphalara suedae*, F. T. Scott, SC), Inglewood (on *Phenacoccus colemani*, P. II. Timberlake collection); San Diego.

Utah: Salt Lake City (NMC).

Arizona: Grand Canyon (CC).

Remarks.—*Cincta* seems to differ from the races of *fimbriolata* more than the latter differ from each other, and this is the reason for considering the former a separate species. Moreover, the distribution area of *cincta* overlaps that of *fimbriolata* without formation of intermediates.

HYPERASPIS PROTENSA Casey

PLATE I, FIGURE 19

Hyperaspis protensa CASEY, 1908, p. 417.

Elongate oval, subdepressed, sides of the elytra feebly arcuate, bluntly rounded behind, pronotum only slightly longer at the middle than on the sides. In the male head yellow, pronotum with a yellow vitta laterally becoming broader toward the anterior angles, the anterior margin black; in females head and pronotum black. Elytra with a pale yellow marginal vitta, the internal outline of the latter bisinuate, the posterior part strongly deflected from the margin, somewhat constricted and expanded into an apical spot. Punctulation dense but fine and rather shallow, that of the elytra being stronger but less dense than that of the pronotum. Femoral lines fail to reach the posterior margin of the segment. Legs yellow, femora infusate in females, abdomen piceous. Genitalia unknown.

Length of the body, 1.8-2.1 mm.; width, 1.2-1.4 mm.

Geographic distribution.—Localities as follows:

Arizona: Nogales (type, CC), Tucson (NMC), Santa Rita Mountains (Th. Dobzhansky).

Remarks.—A bridge between the *postica* and *fimbriolata* groups of species, which are not otherwise closely related, seems to be possible if we compare *protensa* with *subdepressa*, for these two species have a definite external similarity. It is therefore especially regrettable that both of them are known in so few specimens that the structure of the genitalia could not be studied.

HYPERASPIS MARGINATA Gaines

Hyperaspis fimbriolata marginatus GAINES, 1933, p. 263.

Broadly oval, moderately convex, sides of the elytra feebly arcuate, bluntly rounded behind. In males head and pronotum piceous yellow, the latter diffusely darker on the posterior margin in front of the scutellum; in females head and pronotum black, the former becoming lighter on the clypeus, the latter with reddish-yellow lateral and anterior margins. Elytra with a pale yellow marginal vitta very slightly deflected from the margin in its posterior quarter or fifth, rather narrow, the internal outline smoothly curved. Punctulation of the pronotum very fine, interstices alutaceous, that of the elytra moderately dense and strong, interstices nonalutaceous, that of the under side dense but fine. Under side brownish black or piceous, mouth parts and legs yellow, sides of the abdomen lighter than its middle. Prosternal carinae close, reaching almost to the anterior margin, femoral lines very flat, far from attaining the posterior margin of the first abdominal sternite, their outer parts flattened long before reaching the sides of the segment. Genitalia unknown.

Length of the body, 2.5-2.8 mm.; width, 1.9-2.2 mm.

Geographic distribution.—Locality as follows:

Texas: College Station (type, Gaines, NMC).

Remarks.—My original impression after examining this form has been that it represents a race of *fimbriolata*, and I have so advised Dr. Gaines. Now I find the differences between the two justify considering them as separate species, especially since both *marginata* and *fimbriolata* occur at the type locality of the former.

HYPERASPIS DISSOLUTA DISSOLUTA Crotch

PLATE 3, FIGURE 93

Hyperaspis dissoluta CROTCH, 1873, p. 379.—LECONTE, 1880, p. 187.—CASEY, 1899, p. 126.

Oval, moderately convex. In males head yellow, pronotum with yellow lateral margins, in females head and pronotum black. Elytra with a yellow marginal vitta and an apical spot; the former extending

from the humeral angles to two-thirds of the length, rather narrow, distinctly sinuate, the parts corresponding to the humeral and the marginal spots broader than the intervening part, the apical spot transversely oval, lying closer to the margin than to the suture. Punctulation of the upper surface, especially of the elytra, denser but shallower than in *fimbriolata*, that of the under side dense and strong. Mesosternal epimera white in some individuals of either sex, legs brownish yellow, femora infusate, abdomen piceous on the sides. Penis (pl. 5, fig. 138) shorter than the paramera, acuminate distally, the convex side with a tubercle lying closer to the base than to the tip. Female genitalia as in *fimbriolata*.

Length of the body, 2.2-2.8 mm.; width, 1.6-2.2 mm.

Geographic distribution.—Localities as follows:

Nevada: State record (SC).

Arizona: State record (NMC).

California: Siskiyou County, Red Bluff, Chico, Sacramento, Auburn, Lodi, Stockton, Merced, Visalia (a large series, F. T. Scott, SC), Selma, Sequoia Park, South Fork Kings River, Lindsay, Bakersfield, Tejon, Mount Pinos, Lakeport, Guerneville, Mill Valley, Alameda, Piedmont, Oakland, Stanford University, Carmel, Pasadena, Victorville.

HYPERASPIS DISSOLUTA COLORADANA Casey

PLATE 3, FIGURE 94

Hyperaspis coloradana CASEY, 1908, p. 417.

Larger, more elongate, and less convex than the typical form, punctulation of the elytra somewhat stronger, the marginal vitta on the elytra a little or not at all sinuate, its width subequal in all parts. Genitalia identical with those of the typical form.

Length of the body, 2.4-3.0 mm.; width, 1.8-2.1 mm.

Geographic distribution.—Localities as follows:

Montana: Gallatin County (NMC).

Minnesota: Cook County, Shore of Lake Superior (University of Minnesota collection).

Oregon: State record (University of Minnesota collection).

Colorado: Boulder (type, CC).

Texas: Val Verde County (D. J. and J. N. Knull, SC), Austin, Sheffield (T. O. Martin, CASC).

Remarks.—The differences between *dissoluta dissoluta* and *dissoluta coloradana* are so slight that it is questionable whether they are worth treating as distinct subspecies. The specific distinction between *dissoluta* and *fimbriolata* is, on the other hand, clear enough: they occur together without forming intergrades.

HYPERASPIS SANCTAE-RITAE, new species

PLATE 3, FIGURE 92

Broadly oval, moderately convex. Head in males yellow, pronotum with narrow yellow vittae laterally, the width of the vittae increasing anteriorly, the anterior margin of the pronotum black; females unknown. Elytra with a yellow marginal vitta extending from the humeral angles to nine-tenths of the length, the interior outline of the vitta strongly bisinuate, the apical end deflected from the margin, rounded, not protracted forward, somewhat wider than the basal part of the vitta. Punctulation of the pronotum dense and strong, that of the elytra less dense but stronger, and that of the under side moderately dense and strong. Legs brownish yellow, hind femora infusate, meso-sternal epimera black, sides of the abdomen piceous. Penis (pl. 5, fig. 142) nearly as long as the paramera, very narrow, sides sub-parallel for two-thirds of the length, the distal end truncate. Paramera long and slender. Female genitalia unknown.

Length of the body, 2.2-2.5 mm.; width, 1.3-1.5 mm.

Type and two paratypes.—U.S.N.M. No. 54213.

Geographic distribution.—Localities as follows:

Arizona: Santa Rita Mountains (3 ♂♂, including the type, collection Hubbard and Schwarz, now in NMC), Nogales (1 ♂, Koebele, CASC).

Remarks.—This species is set apart from its relatives known to me principally by the structure of its genitalia. It appears to be related to *psyche* more closely than to the rest.

HYPERASPIS PSYCHE Casey

PLATE 3, FIGURE 88

Hyperaspis psyche CASEY, 1899, p. 125.

Oval, moderately convex, sides of the elytra feebly arcuate, obtusely rounded behind. In males head yellow with a black stripe on the vertex, pronotum with a yellow stripe on the lateral margin, the stripe broader anteriorly than posteriorly, the anterior margin black; in females head and pronotum black. Elytra with yellow humeral, marginal, and apical spots; the humeral one triangular; the marginal more or less semicircular; the apical one rather small in some individuals and the largest of the three in others, rounded or transversely oval; in two individuals from Lebec (see below) traces of a longitudinally oval discal spot are present. Punctulation moderately sparse and fine, that of the elytra stronger than that of the pronotum. Legs brownish yellow, femora infusate, abdomen more or less piceous. Femoral lines broad, their middle parts running parallel to the hind

margin of the segment. Penis (pl. 5, fig. 143) markedly shorter than the paramera, rounded at the distal end, the convex side devoid of any sharp prominence, paramera long and slender. Female genitalia as in *fimbriolata*.

Length of the body, 2.3-2.7 mm.; width, 1.7-1.9 mm.

Geographic distribution.—Localities as follows:

California: Alameda County (type, CC), Muir Woods, Fairfax, Lagunitas, Pinnacles National Monument, Contra Costa County, Sequoia National Park, Kern County, Lebec (a fairly large series, F. T. Scott, SC), Mojave, Pasadena, Forest Home, San Diego.

Remarks.—The population of Lebec differs from others by having the spots enlarged and in some cases having discal spots which are not present in any other species of *fimbriolata* group. It is possible that a separate race is here involved.

X. DISCONOTATA GROUP

Here belong a large number of Mexican and Central American forms. In the United States this group is represented by an aberrant species (*disconotata*) and by a species (*trifurcata*) which more nearly resembles its tropical relatives. The color pattern of the elytra consists of the whole typical set of the spots (i.e., five on each elytron), which by confluence may give rise to a series of black designs on a pale background which at first sight are difficult to derive from the type pattern. Penis and the paramera long, the former with a sharp toothlike tubercle on one side. Capsule of the spermatheca retort-shaped, gradually passing into the connecting duct.

HYPERASPIS DISCONOTATA DISCONOTATA Mulsant

PLATE 2, FIGURE 65

Hyperaspis disconotata MULSANT, 1850, p. 653.—LLCONTE, 1880, p. 187.—CASEY, 1899, p. 127.

Oval, little convex, maximum width of the body reached in front of the middle of the length, somewhat acuminate posteriorly. In males head yellow with a black fascia on the vertex that is wider on the sides than in the middle, pronotum with yellow stripes on the lateral and anterior margins, the stripes of a uniform width throughout; in females head and pronotum black. Elytra with five yellow spots of the basic pattern of the genus; humeral spot triangular, its side adjacent to the external margin about twice as long as that adjacent to the basal margin; basal spot, separated from the humeral one merely by a black line, subtriangular; marginal spot three or more times longer

than wide; discal spot longitudinally oval, at least twice as long as wide; apical spot transversely oval. Punctulation of the pronotum fine and rather sparse, interstices clearly alutaceous, that of the elytra appreciably stronger, interstices barely perceptibly alutaceous, that of the under side strong on the metasternum and very fine on the abdomen, interstices clearly alutaceous. Mouth parts and legs yellow, hind femora brown at base, abdomen brownish black in males; in females mouth parts and legs brown, tibiae and tarsi lighter than the femora. Prosternal carinae rather weak, fused just in front of the middle of the segment; femoral lines very broad, their external portions rather angular. Penis (pl. 5, fig. 131) almost as long as the paramera, rather narrow, the distal end blunt, the convex side with a toothlike tubercle located in front of the middle of the length. Female genitalia unknown.

Length of the body, 2.9-3.4 mm.; width, 2.2-2.5 mm.

Geographic distribution.—Localities as follows:

Michigan: White Fish Point, Lake Superior (NMC).

Illinois: Northern part (Peabody collection, now at Illinois Natural History Survey).

Minnesota: Little Winnebegosish (K. Cooper, NMC).

HYPERASPIS DISCONOTATA TROGLODYTES Mulsant

PLATE I, FIGURE 31

Hyperaspis troglodytes MULSANT, 1853, p. 219.—CASEY, 1899, p. 127.

Hyperaspis discreta LECONTE, 1880, p. 187.

Smaller than the typical form, more broadly oval, not acuminate posteriorly, more strongly convex, maximum width reached at about the middle of the body length, as in most other species of *Hyperaspis*. Coloration of the head, pronotum, and the under side as in the typical *disconotata*, except that in *troglodytes* the yellow lateral margin of the pronotum is broader than the anterior margin in males. All the elytral spots more or less rounded; the humeral one rounded equilaterally triangular, the basal semicircular, the discal round or slightly longitudinally oval, the marginal semicircular, the apical rounded or transversely oval; the humeral and basal spots separated by at least half their own diameter. Penis as in the typical form but the distal end acuminate instead of blunt. The capsule of the spermatheca retort-shaped, basal portion moderately long, with a fairly large appendix.

Length of the body, 2.6-3.2 mm.; width, 1.9-2.3 mm.

Geographic distribution.—Localities as follows:

New Brunswick: Penobsquis (C. A. Frost, San Diego Museum collection).

Massachusetts: Sherborn, Rochester.

New York: Cascade, West Point.

Pennsylvania: Mount Alto.

Virginia: Skyland (Quirsfeld, SC).

Indiana: Orange County.

Iowa: Mount Pleasant, County No. 21 (SC).

Remarks.—The typical *disconotata* and *troglydites* differ so strongly that at first sight there seems to be no question that they are distinct species. And yet, a complete series of intergrades between them has been observed. Individuals from Minnesota, Iowa, and Indiana are all intermediates, and assigning them to one or the other subspecies is a matter of taste. The typical *disconotata* is found on Lake Superior, the pure *troglydites* on the Atlantic seaboard.

HYPERASPIS DISCONOTATA CANADENSIS, new subspecies

PLATE 1, FIGURE 34

Smaller, more oblong oval, and less convex than the typical *disconotata*, not acuminate posteriorly. The yellow vittae on the pronotum in the male unequal in width, the anterior being narrower than the lateral ones. The humeral, marginal, and apical spots of the elytra fused to form a narrow trisinate marginal vitta slightly deflected from the margin in its posterior fifth; basal spot small, rounded, in one individual completely missing; discal spot very much elongated, at least four times longer than wide, in one individual fused with the basal spot to form a longitudinal vitta from the base to the apical fifth. Punctulation stronger than in the other two races of the species. Genitalia unknown.

Length of the body, 2.4-2.7 mm.; width, 1.7-1.9 mm.

Type.—In collection of F. T. Scott.

Paratype.—U.S.N.M. No. 54214.

Geographic distribution.—Locality as follows:

Alberta: Whitford Lake (six individuals including the type, O. Bryant, SC).

Remarks.—Although only six individuals of this form have been seen, considerable variation has been observed in the color pattern of the elytra. Further material is highly desirable.

HYPERASPIS TRIFURCATA Schaeffer

PLATE 3, FIGURE 101

Hyperaspis trifurcata SCHAEFFER, 1905, p. 143.

Broadly oval, somewhat obtusely rounded behind, moderately convex. In males head orange, in females black on the vertex, gradually becoming brown and brownish red on the clypeus. Pronotum in both

sexes with orange stripes laterally, the width of the stripes tending to be greater in males. The ground color of the elytra varying from blood red, through brick red, to orange yellow, with a trident-shaped black design. The extent of the black pattern varying considerably: the red parts separating the prongs of the trident (corresponding to the discal spots) may become isolated to form spots, or may disappear giving rise to black elytra with undulated red vittae on all margins, interrupted by the black at the scutellum and at the apex. Punctulation of the pronotum dense and moderately strong, interstices alutaceous, that of the elytra less dense but about as strong as that of the pronotum, interstices polished. Mouth parts, legs, and margins of the abdomen brick red, femora darker, especially in females. Prosternal carinae well developed, femoral lines broadly and evenly arcuate. Penis (pl. 5, fig. 132) as long as the paramera, narrow and parallel sides basally, its distal end shaped like an eagle's beak. Female genitalia (pl. 6, fig. 158) resembling those of *disconotata*.

Length of the body, 2.4-3.0 mm.; width, 1.9-2.1 mm.

Geographic distribution.—Localities as follows:

Texas: Brownsville (on *Dactylopius confusus*), Falfurrias, San Diego, Kerrville, Hebbronville (on *Coccus cacti*), San Antonio, Seguin, Floresville, Tivoli, Corpus Christi, Los Borregos, Victoria, Alice, Sabinal, Fort Isabel, Uvalde (on *Dactylopius tomentosus*), Houston, College Station, and Sheffield, Pecos County.

Remarks.—There can be no doubt about *disconotata* and *trifurcata* being distinct species, although their distribution areas nowhere overlap, and therefore no opportunity to observe intermediates between them is available. On the other hand, in Mexico and Central America a number of "species" occur which are very likely to prove only sub-specifically distinct from *trifurcata*. To this category belong in the first place Casey's species *durangoensis* and *disjunctus*. Judging from the types, these two are individual variants of the same form, and both are in all probability only races of *trifurcata*. Schaeffer himself (1905) suggested that *trifurcata* may be closely related to *guatemalensis* Gorham, but the latter species is not familiar to me.

XI. UNDULATA GROUP

Among the species of *Hyperaspis* inhabiting the United States this group is probably the most difficult one as far as distinguishing species is concerned. It consists of two subgroups, one centering around *undulata*, and the other around *quadrioculata*; the latter is the more difficult of the two. The elytral pattern includes the humeral, marginal, discal, and apical spots; the first, second, and fourth of these are

frequently fused to form a marginal vitta. Male genitalia are characterized by penis and paramera being both long and slender, and by strong, though short, basal plates. In the female genitalia the capsule of the spermatheca is retort-shaped, gradually passing into the connecting duct.

HYPERASPIS UNDULATA (Say)

PLATE 2, FIGURE 56

Coccinella undulata SAY, 1824, p. 92.—MULSANT, 1850, p. 1049.—CASEY, 1899, p. 128.

Hyperaspis maculifera MELSHEIMER, 1847, p. 179.—LECONTE, 1880, p. 189.

Hyperaspis elegans MULSANT, 1850, p. 658.—LECONTE, 1880, p. 189.

Oval, slightly acuminate posteriorly, moderately convex. In males head yellow, pronotum with yellow lateral and anterior margins, the lateral yellow stripes being parallel-sided and rather narrow; in females head black, pronotum with only the lateral margins yellow. Elytra with a yellow sharply sinuate marginal vitta which is broadest in the apical region, and a longitudinally oval or rounded discal spot. In some individuals the marginal vitta resolved into humeral, marginal, and apical spots, the last being the largest. Punctulation of the pronotum dense and fine, interstices alutaceous, that of the elytra less dense but much stronger, interstices nonalutaceous, that of the under side dense and rather fine. Legs yellow, femora infusate in females. Penis as long as, or longer than, the paramera, of a characteristic shape shown in plate 5, figure 126, its distal end broadly rounded. The proximal portion of the spermatheca short and broad, with a large appendix.

Length of the body, 2.3-2.7 mm.; width, 1.4-1.9 mm.

Geographic distribution.—From Canada to Virginia and west to Minnesota, Nebraska, Colorado, Utah, and Texas.

Remarks.—Individuals from the middle western States have the yellow pattern on the elytra more strongly developed than those from the Atlantic seaboard, and it may prove desirable to designate the western race as a separate subspecies.

HYPERASPIS OCTAVIA Casey

PLATE 1, FIGURE 7

Hyperaspis octavia CASEY, 1908, p. 419.

Very similar to *undulata*, but more broadly oval, rounded behind, a little more strongly convex. The yellow stripe on the lateral margin of the pronotum almost always broader anteriorly than posteriorly, and sometimes reduced to a yellow triangular spot in the anterior

angles. Elytra with four yellow spots each: humeral spot triangular, marginal semicircular, apical transversely oval, and the discal one rounded or slightly longitudinally oval. Punctulation of the pronotum stronger than in *undulata*. Penis (pl. 5, fig. 128) large, longer and narrower than in *undulata*, truncate distally. Female genitalia as in *undulata*.

Length of the body, 2.3-2.8 mm.; width, 1.7-2.1 mm.

Geographic distribution.—Localities as follows:

Maine: Casco Bay (G. P. Engelhardt, SC).

New Hampshire: Claremont (SC).

Vermont: Mount Mansfield (NMC).

Massachusetts: Lexington, Sherborn, Cambridge, Framingham, Saugus.

New York: Rockaway Beach, West Point, Ithaca, Buffalo, top of Mount Whiteface.

Maryland: Patuxent River.

Virginia: Fortress Monroe, Fairfax.

Mississippi: Vicksburg (type, CC).

Michigan: Detroit, Golden Ledge.

Minnesota: Ramsey County, Battle Creek (University of Minnesota collection).

Remarks.—This species is close to *undulata*, and is superficially so similar to individuals of the latter species having the marginal vitta resolved into separate spots that it is misdetermined as *undulata* in most collections. The differences between the two species are numerous though small: body shape, punctulation of the pronotum, shape of the yellow vitta on the lateral margin of the pronotum and of the discal spot. Male genitalia are rather strikingly different. The geographic distributions of *octavia* and *undulata* are similar though not identical, and although the two species seem to occur side by side no intermediates are found.

HYPERASPIS PALUDICOLA Schwarz

PLATE 2, FIGURE 51

Hyperaspis paludicola SCHWARZ, 1878, p. 362.—LECONTE, 1880, p. 188.—CASEY, 1899, p. 128.

Small, elongate, little convex, sides of the pronotum feebly convergent anteriorly, sides of the elytra subparallel from the base to three-fourths of the length, thence rounded, and slightly acuminate at the apex. In males head yellow with a black bisinuate stripe on the vertex, pronotum with a rather broad yellow stripe on the lateral and a much narrower one on the anterior margins; in females head black, pronotum with only the lateral margins yellow. Elytra with a feebly undulate marginal vitta from the base nearly to the apex, and with a rather large longitudinally oval discal spot. Pronotum strongly aluta-

ceous, punctulation sparse and very fine, elytral punctures strong and moderately dense, interstices feebly or not at all alutaceous, under side, except the sides of the metasternum, finely and sparsely punctulate. Legs yellow, abdomen or the whole under side piceous. Femoral lines broad, their external parts strongly angulate, not attaining either the posterior or the side margin of the first abdominal sternite; prosternal carinae very close, reaching forward to two-thirds of the length of the segment. Penis (pl. 5, fig. 127) long and narrow, the distal end rounded. The capsule of the spermatheca small, the proximal portion very small, with a large appendix.

Length of the body, 1.7-2.2 mm.; width, 1.1-1.4 mm.

Geographic distribution.—Localities as follows:

Florida: Tampa, Capron, Baldwin, Enterprise, Haw Creek, Ashby, Steinhatchee, Kissimmee (NMC, CC).

Alabama: Mobile (H. P. Loding, SC).

South Carolina: Sassafras Mountain (O. L. Cartwright, SC).

Virginia: Wingina (W. T. Davis collection).

?? Massachusetts: Provincetown (SC).

Remarks.—Individuals from States other than Florida are somewhat larger, and may represent a separate race. The finding of this species at Provincetown requires confirmation.

HYPERASPIS PUNCTATA Leconte

PLATE 2, FIGURE 50

Hyperaspis punctata LECONTE, 1880, p. 188.

Elongate, little convex, sides of the pronotum feebly convergent anteriorly, the sides of the elytra subparallel, the apical part obtusely rounded and not at all acuminate. Head yellow in males and black in females, pronotum in both sexes with yellow lateral and black anterior margins. Elytra with a strongly sinuate yellow marginal vitta extending from the base to slightly more than the middle of the length, a round discal spot located distinctly in front of the middle of the length, and a transversely oval apical spot. Punctulation of the pronotum moderately dense and strong, that of the elytra only slightly stronger, interstices very faintly or not at all alutaceous, that of the under side sparse and fine, except on the metasternum where it is strong. Legs yellow, under side varying from dark piceous to light brown. Femoral lines and prosternal carinae as in *paludicola*, but the former much narrower. Penis (pl. 5, fig. 129) very small, almost parallel-sided at base, asymmetry not strongly pronounced, the tip rounded. Female genitalia unknown.

Length of the body, 2.2-2.7 mm. ; width, 1.3-1.7 mm.

Geographic distribution.—Localities as follows:

South Dakota: Belvidere (K. Cooper, NMC).

Texas: Belfrage, Gregory, Cotulla, Victoria, Brownsville.

New Mexico: Clovis (NMC).

HYPERASPIS FILIOLA Casey

PLATE 1, FIGURE 8

Hyperaspis filiola CASEY, 1908, p. 419.

Body shape resembling that of *punctata*. In the type (a female) head and pronotum black, elytra with a yellow marginal vitta extending from the base nearly to the apex, its internal outline only slightly undulate, and with a longitudinally oval discal spot the center of which lies behind the middle of the length of the elytron. Punctulation of elytra and the pronotum almost equally dense and strong, interstices not alutaceous, that of the under side much finer, except on the metasternum. Tibiae and tarsi brownish yellow, the rest of the under side dark piceous. Femoral lines as in *punctata*. Genitalia unknown.

Length of the body, 2.1 mm. ; width, 1.2 mm.

Geographic distribution.—Locality as follows:

Arizona: Nogales (type, CC).

Remarks.—I have seen only the single type specimen of this species, which shows a curious mixture of the distinctive characters of *punctata* and *paludicola*. Further material is needed before the status of *filiola* can be determined.

HYPERASPIS QUADRIOCULATA QUADRIOCULATA (Motschulsky)

PLATE 2, FIGURE 57

Exochomus quadrioculata MOTSCHULSKY, 1845, p. 383.—MULSANT, 1850, p. 676.—LECONTE, 1880, p. 188.—CASEY, 1899, p. 128; 1908, p. 418.

Greatly variable in size, elongate oval, little convex. In males head yellow with a black bisinuate stripe on the vertex, in females head black. Pronotum in both sexes with a narrow yellow stripe on the lateral margins. Elytra with yellow suffused with brown discal and apical spots, and, in individuals intermediate between *quadrioculata* and *quadrioculata notatula*, with traces of humeral and marginal spots. The discal spot round or longitudinally oval, the apical one transversely oval. Punctulation of the pronotum very dense but fine, interstices very faintly alutaceous, that of the elytra a little less dense but much stronger, that of the abdomen sparse and fine, that of the sternum dense and very coarse. Under side black or dark piceous,

tibiae, tarsi, and parts of femora yellow in males, fuscous in females. Prosternal carinae strongly developed, reaching close to the anterior margin, femoral lines large, their inner parts steep, middle parts subparallel to the posterior margin of the first sternite, outer parts more or less angular. Penis (pl. 5, fig. 130) long and narrow, gradually narrowing distally, truncate at the end; paramera long and slender. The proximal portion of the spermatheca elongate, with a large appendix.

Length of the body, 2.2-3.3 mm.; width, 1.2-2.3 mm.

Geographic distribution.—Localities as follows:

California: Mendocino County (San Diego Museum collection), Sonoma County, Santa Rosa, Lagunitas, Fairfax, Mill Valley, Martinez, Mount Diablo, Vine Hill, Alhambra Valley, Berkeley, Oakland, Piedmont, Alameda, San Francisco, San Pablo, Milbrae, Crystal Lake, Burlingame, Stanford University, Sunnyvale, Santa Clara, Niles, Pacific Grove, Carmel, Monterey, Adams Springs, Lake County, Davis, Yuba County, Sacramento, Lodi (reared from Baker's mealybug infesting grapes, F. T. Scott), Stockton, Tracy, Sequoia National Park, Potwisha.

HYPERASPIS QUADRIOCULATA NOTATULA Casey

PLATE 2, FIGURE 59

Hyperaspis notatula CASEY, 1899, p. 121; 1908, p. 418.

Differs from the typical *quadrioculata* by being somewhat more broadly oval, by having the yellow stripes on the lateral margins of the pronotum wider, and by having the spots on the elytra well defined and bright yellow in color. Humeral and marginal spots present, the former triangular in shape, sometimes reduced to a yellow streak, the latter semicircular. The discal spot larger than in *quadrioculata quadrioculata*, longitudinally oval, apical spot also larger, transverse; in a few individuals the discal spot obsolete, producing a superficial resemblance to *psyche*. Genitalia identical with those of the typical form.

Length of the body, 2.2-2.6 mm.; width, 1.4-1.9 mm.

Geographic distribution.—Localities as follows:

Nevada: Reno (type, CC).

California: Marin County, Sonoma County, San Joaquin County, Stockton, Laguna Mountains, Ahwahnee, South Fork Kings River, Sequoia National Park, Kaweah, Potwisha, Tulare, Visalia, Kern County, Pacific Grove, Monterey, Carmel, Pinnacles National Monument, Tassajara, Havilah, San Luis Obispo, Paso Robles, Santa Paula, Santa Barbara, Los Angeles, Pasadena, Mount Lowe, Mount Wilson, Sierra Madre, Bishop.

Arizona: Benson, Nogales (C. W. Leng collection).

Remarks.—Casey first thought *notatula* to be a relative of *lateralis*, but later has correctly recognized its similarity to *quadrioculata*. Indeed, although the extreme specimens of the two forms appear to be

rather widely different, all the intermediates have been found (in San Joaquin Valley of California), and I consider the subspecific status of *notatula* established.

HYPERASPIS QUADRIOCULATA SCOTTI, new subspecies

PLATE 2, FIGURE 58

Pale markings on the head and the pronotum more strongly developed than in the typical *quadrioculata*, orange yellow in color. Elytra without the humeral spot, but with the other spots of the typical pattern very large, bright orange yellow in color, the marginal and discal ones broadly confluent. Genitalia identical with those of the typical form.

Length of body, 2.4-2.6 mm.; width, 1.6-1.8 mm.

Type.—In collection of F. T. Scott.

Paratype.—U.S.N.M. No. 54215.

Geographic distribution.—Localities as follows:

California: San Joaquin County (9 individuals including the type, F. T. Scott, SC), Lodi (3 individuals, reared from Baker's mealybug infesting grapes, SC, P. H. Timberlake collection), Stockton (one individual, E. P. Van Duzee, CASC).

Remarks.—This seems to be a narrowly localized race of *quadrioculata*; no intermediates between it and the typical form or the subspecies *notatula* have been found despite the fairly large number of individuals examined, which suggests that *scotti* differs from the other subspecies in a genetically simple way.

HYPERASPIS QUADRIOCULATA FIDELIS Casey

PLATE 1, FIGURE 9

Hyperaspis fidelis CASEY, 1908, p. 418.

More broadly oval than other races of *quadrioculata*. Coloration of the head and pronotum as in subspecies *notatula*. Elytra with a yellow marginal vitta extending from the base to two-thirds of the length, the internal outline of the vitta feebly sinuate, its maximum width attained at the level corresponding to the marginal spot of the basic pattern; discal spot large, longitudinally oval or wedge-shaped, apical spot large, transversely oval, sometimes showing a tendency toward confluence with the marginal vitta. Elytral markings bright yellow, clearly defined. Punctulation of the elytra and the pronotum dense and rather fine. Genitalia identical with those of the typical form.

Length of the body, 1.9-2.6 mm.; width, 1.4-1.8 mm.

Geographic distribution.—Localities as follows:

California: Pinnacles National Monument, Santa Paula, Los Angeles, Laguna Mountains, Pala, Escondido (beaten from lemons infested with mealybugs, F. T. Scott), Julian, Potrero, Warner Hot Springs, Cuyamaca, San Diego.

Remarks.—This is the southernmost known race of *quadrioculata*, which in the north merges into *quadrioculata notatula*.

HYPERASPIS TRIANGULUM Casey

PLATE I, FIGURE 10

Hyperaspis triangulum CASEY, 1899, p. 123.

Oval, somewhat obtusely rounded behind, moderately convex. In males head yellow with a black bisinuate stripe on the vertex, in females black. Pronotum in both sexes with yellow stripes on the lateral margins which are about twice as long as wide and slightly narrower posteriorly than anteriorly, the anterior margin black. Elytra with yellow spots: a rounded or wedge-shaped discal one lying in front of the middle of the length, a semicircular or elongate marginal one located behind the middle, and a transversely oval apical one; in some individuals a yellow or brownish streak marks the position of the rudimentary humeral spot. Punctulation of the pronotum moderately dense and fine, that of the elytra almost as dense but appreciably stronger, that of the under side fine and sparse, except on the sternum where it is dense and coarse, interstices not alutaceous. Legs brownish yellow, femora infusate in females, abdomen varying from light piceous to black. Prosternal carinae reaching to within a short distance of the anterior margin, femoral lines arcuate, their outer parts flatter than the inner ones, barely touching the posterior margin of the segment. Genitalia unknown.

Length of the body, 2.0-2.5 mm.; width, 1.6-1.9 mm.

Geographic distribution.—Localities as follows:

Texas: Finlay (J. O. Martin, CASC).

Arizona: Benson (type, CC).

California: Bear Flats, Julian (P. H. Timberlake collection), Cuyamaca, San Diego (San Diego Museum collection).

Remarks.—Casey considered *triangulum* to be a member of the *gemma* group; its very close relation to *quadrioculata* seems clear to me, even though the genitalia of *triangulum* are unknown. The California specimens of *triangulum* have larger elytral spots than Casey's type specimen which comes from Arizona. It is possible that the California population will have to be recognized as a separate subspecies, but more material is necessary to decide this point.

HYPERASPIS SPICULINOTA Fall

PLATE 2, FIGURE 60

Hyperaspis spiculinota FALL, 1901, p. 232.

Large, elongate oval, little convex, sides of the elytra subparallel for two-thirds of the length, very obtusely rounded behind. Head yellow with a black stripe on the vertex in males, black in females. Pronotum in both sexes with yellow stripes on lateral margins which are two or more times longer than wide, the anterior margin black. Elytra with a large, elongate, clearly wedge-shaped, yellow discal spot, a marginal spot that is from two to three times longer than wide, and a large transverse apical spot. Punctulation dense but rather fine, that of the elytra only slightly stronger than that of the pronotum, that of the under side sparse and fine, except on the sides of the metasternum where it is strong, interstices not alutaceous. Legs brownish yellow, femora and parts of the tibiae fuscous. Prosternal carinae reaching almost to the anterior margin, femoral lines angular externally, their middle parts running parallel to the posterior margin of the segment. Penis (pl. 5, fig. 133) long, rapidly narrowing distally and acuminate at the tip. The proximal portion of the spermatheca relatively shorter and broader than in *quadrioculata*.

Length of the body, 2.4-3.0 mm.; width, 1.7-2.1 mm.

Geographic distribution.—Localities as follows:

California: Pasadena, Monrovia, San Gabriel Canyon, Pomona, mountains near Claremont, Santa Barbara County (SC), Sequoia National Park (SC).

Remarks.—Although related to *quadrioculata*, *spiculinota* must be considered a separate species. It is endemic in southern California, and fairly common in the foothills of the Sierra Madre range. The single individual from Sequoia Park has the marginal spot reduced in size, semicircular instead of oblong.

HYPERASPIS SIMULATRIX, new species

Elongate oval, rather obtusely rounded behind. Head yellow with a broad black bisinuate stripe on the vertex in males, black in females. Pronotum in both sexes with yellow stripes on lateral margins, the stripes being two to three times longer than wide, the anterior margin black. Elytra with a yellow marginal vitta extending from the base to three-fifths of the length, the vitta narrow, undulate internally, attaining its maximum width in the region corresponding to the marginal spot; the discal spot longitudinally oval, in the type about three times longer than wide, in one of the cotypes only one and one-half times

longer than wide; apical spot large, transversely oval. Punctulation of the pronotum dense but fine, that of the elytra only slightly sparser and stronger, that of the under side sparse and fine, except on the metasternum, interstices not alutaceous. Legs brownish yellow, femora and tibiae fuscous. Prosternal carinae well developed, reaching to three-quarters of the length of the segment, femoral lines broad, their middle parts parallel to the posterior margin, the outer parts angular. Penis (pl. 5, fig. 135) longer than the paramera, very long and slender, attaining its maximum width at about one-third of the length from the base, gradually narrowing distally. Paramera long and slender, basal plates short. Female genitalia unknown.

Length of the body, 2.2-2.5 mm.; width, 1.6-1.8 mm.

Type and three paratypes.—U.S.N.M. No. 54216.

Geographic distribution.—Localities as follows:

Idaho: Oakley (D. E. Fox, type, NMC), Wendell (Wind Vane trap, NMC), Hollister (D. E. Fox, NMC).

Montana: State record (H. K. Morrison, NMC).

Washington: Touchet (H. P. Lanchester, SC).

Remarks.—This species is related to *quadrioculata*, and its color pattern resembles that of *quadrioculata fidelis*. The striking difference in the structure of the male genitalia suggests however the two should be considered distinct species. It must also be noted that the geographic areas of *quadrioculata* and *simulatrix* are separated by a territory where no species of this group is known to occur; further exploration of this territory is evidently desirable.

XII. ANNEXA GROUP

Here belong five forms inhabiting the United States, which are closely related and represent relatively recent differentiation products of a single ancestral species. Nevertheless, some of them have become so different that they must now be classed as independent species. The elytral pattern consists of two longitudinal vittae, one of which is located on the outer margin and represents the fusion product of the numeral, marginal, and apical spots, and the other lies on the disk and must be regarded as a greatly elongated discal spot; the two vittae are sometimes fused, giving rise to pale elytra with a black design. Body shape elongate oval, feebly convex. Male genitalia are characterized by strongly elongate penis and paramera, and relatively short and weak basal plates. The capsule of the spermatheca retort-shaped, gradually passing into the connecting duct.

HYPERASPIS ANNEXA Leconte

PLATE 3, FIGURE 96

Hyperaspis annexa LECONTE, 1852, p. 133; 1880, p. 188.—CASEY, 1899, p. 128.

Oval, obtusely rounded behind, little convex, sides of the elytra feebly arcuate. In males head yellow with a black stripe on the vertex usually covered by the pronotum, pronotum with a broad vitta laterally which is as wide as, or wider than, long, and a broad vitta of the same color on the anterior margin, leaving only the central part of the pronotum black; in females head black, pronotum with yellow lateral margins which are as long as, or longer than, wide. Elytra with broad yellow marginal and discal vittae which, except very rarely, are broadly fused in the apical part; in some individuals the vittae tend to fuse at the basal margin as well, so that the elytra become yellow with a black vitta on the suture and another on the outer part of the disk. Pronotum densely and rather strongly, elytra less densely and somewhat more finely, punctulate, punctulation of the under side moderately dense and fine. Mouth parts and legs yellow, abdomen piceous, in females femora somewhat darker. Prosternal carinae rather close to each other but reaching far forward, femoral lines running for a distance parallel to the posterior margin of the segment, their outer parts angular. Penis (pl. 5, fig. 148) as long as the paramera, narrowing distally, and curved at the distal end. Basal part of the spermatheca elongate.

Length of the body, 2.2-2.7 mm.; width, 1.6-1.9 mm.

Geographic distribution.—Localities as follows:

California: Berkeley, Alameda, San Francisco, San Mateo County, Santa Paula, Ventura County, Santa Maria, Los Angeles, Pasadena, San Bernardino County, Colton, Bear Lake, San Diego (beaten from locusts infested with mealybugs, F. T. Scott), Playa del Rey, Isabella, Tulare County.

Idaho: Hansen (NMC).

Remarks.—The development of the pale color pattern on the elytra is greater in individuals from southern California than in those from the San Francisco Bay region. The only individual seen from Idaho, a female, may represent a very lightly pigmented specimen of *quadrivittata*, but it seems to be more like *annexa* than the former species.

HYPERASPIS QUADRIVITTATA QUADRIVITTATA Leconte

PLATE 3, FIGURE 98

Hyperaspis quadrivittata LECONTE, 1852, p. 133; 1880, p. 188.—CASEY, 1899, p. 128.

Elongate oval, obtusely rounded behind, very little convex, sides of the elytra feebly arcuate. In males head yellow anteriorly and black

posteriorly, the black part forming a triangular process reaching in some individuals almost to the base of the labrum; in females head black. Pronotum in both sexes with a yellow lateral margin which is longer than wide. Elytra with yellow or yellowish-white marginal and discal vittae, both vittae narrow, the discal one extending from one-sixth to four-fifths of the length, its side subparallel, the marginal one extending from the humeral angles almost to the suture and the posterior end of the discal vitta, parallel-sided or slightly sinuate, somewhat deflected in the apical fourth from the margin, and in a few individuals almost fused with the discal one. Punctulation of the pronotum and the elytra uniformly dense and rather strong. Under side varying in color from piceous to black, mouth parts and legs yellow or fuscous. Penis (pl. 5, fig. 149) shorter than the paramera, less elongate than in *annexa*, and provided with a distinct triangular process located much nearer to the tip than to the base. Female genitalia as in *annexa*.

Length of the body, 2.0-2.7 mm.; width, 1.3-1.8 mm.

Geographic distribution.—Localities as follows:

Alberta: Medicine Hat (F. R. Carr, SC), Banff Springs (NMC).

Montana: Helena (NMC), Gallatin County (NMC).

Idaho: Parma, Buhl, Hollister.

Wyoming: Cheyenne, Yellowstone Park.

Iowa: Lake Okoboji (NMC).

Nebraska: Lincoln (NMC).

Colorado: Colorado Springs, Denver, Peaceful Valley.

New Mexico: Torrance County, Las Vegas (NMC).

Utah: Alta.

Arizona: Winslow (C. W. Leng collection).

***HYPERASPIS QUADRIVITTATA* variety *TETRANEURA* Casey**

Hyperaspis tetraneura CASEY, 1908, p. 420.

Differs from the typical *quadrivittata* in having the yellow vittae on the elytra very narrow, the marginal one abbreviated, reaching only to two-thirds of the length of the margin. Genitalia identical with that of the typical form.

Geographic distribution.—Localities as follows:

Colorado: Boulder County (type, CC), Colorado Springs, Buena Vista (C. W. Leng collection).

New Mexico: Las Vegas (NMC).

Utah: Alta (NMC).

Remarks.—This appears to be a geographically localized color form of *quadrivittata*. I find no difference between them in the convexity of the body and the shape of the femoral line, as alleged by Casey (1908).

HYPERASPIS OREGONA, new species

PLATE 3, FIGURE 99

Oval, little convex, less obtusely rounded behind than the preceding species. In males head yellow with a broad undulate black stripe on the vertex, black in females. Pronotum in either sex with yellow lateral margins, the yellow areas being much longer than wide, with or without a very narrow yellow stripe on the anterior margin in males. Elytra with a yellow marginal vitta extending from the humeral angles to two-thirds of the length of the margin, usually broader in its anterior and posterior than in its middle part, a small transversely oval apical spot usually well separated from the end of the marginal vitta, and a yellow discal vitta extending from one-third to two-thirds of the length of the elytron, usually broader in its anterior than in its posterior half. Pronotum densely and finely, elytra less densely but more strongly, punctulate, interstices not alutaceous, under-side punctulation fairly sparse. Mouth parts and legs brownish yellow, femora infusate, especially in females. Prosternal carinae and femoral lines as in *annexa*. Genitalia of both sexes resembling those of *annexa*, except that the penis (pl. 5, fig. 147) is more elongate and more uniformly broad.

Length of the body, 2.1-2.5 mm.; width, 1.5-1.7 mm.

Type.—In collection of F. T. Scott.

Four paratypes.—U.S.N.M. No. 54217.

Geographic distribution.—Localities as follows:

Oregon: Harney County (E. B. Leach, 2 ♂♂ including the type, SC), Harper (H. P. Lancaster, SC).

Washington: Walla Walla (H. P. Lancaster, SC), Wawawai (H. P. Lancaster, SC), Toppenish (D. Dunavan, SC).

Idaho: Craters of the Moon (D. J. and J. N. Knull, SC), Hollister (Wind Vane trap, NMC), Centerville (J. L. Webb, NMC).

Wyoming: Yellowstone Park (NMC).

Remarks.—This species is in a way intermediate between *annexa* and *quadrivittata*, and may conceivably, though not probably, prove to be a race of the former species.

HYPERASPIS OREGONA BOREALIS, new subspecies

PLATE 1, FIGURE 33

Differs from the typical form by a somewhat more elongate form of the body, and by having the elytra black with a yellow streak at three-quarters of the length of the elytron, located close to one-third of the width from the suture. This streak undoubtedly represents a

remnant of the discal vitta of the type form. The yellow lateral margin on the pronotum somewhat narrower than in the type form, and in one individual nubilate. Genitalia unknown.

Length of the body, 2.4-2.6 mm.; width, 1.6-1.7 mm.

Type.—In collection of F. T. Scott.

Paratype.—U.S.N.M. No. 54218.

Geographic distribution.—Localities as follows:

Washington: Lake Cle Elum (H. P. Lanchester, 1 ♂, type, SC).

British Columbia: Vancouver (H. B. Leach, 1 ♀, SC).

***HYPERASPIS BRUNNESCENS*, new species**

PLATE 3, FIGURE 97

Oval, somewhat obtusely rounded behind, subdepressed. In males head dull brownish yellow becoming darker toward the vertex, in females uniform dark brown. Pronotum more flattened and relatively longer than in related species, variable in color: in the type (♂) dull yellow with hazy infuscate areas on either side of the scutellum, or more or less evenly brownish yellow (♂, ♀), or dark brown becoming paler toward the lateral and the anterior margins (♀). Elytra brownish black with dull yellow vittae of the same type as in *quadrivittata* but somewhat broader, the marginal one more sinuate, the discal one shorter, and both with rather indistinct boundaries. Punctulation of the pronotum dense and fine, that of the elytra less dense but distinctly stronger, interstices in both cases clearly alutaceous, especially on the pronotum. Under side piceous brown, mouth parts, prosternum except on the middle, and legs fuscous yellow, mesosternum, metasternum, and abdomen darker at the middle than on the sides. Prosternal carinae close but reaching far forward, femoral lines in their middle parts running parallel to the hind margin of the segment, strongly angular externally. Male genitalia unknown, female ones like in *annexa*.

Length of the body, 2.3-2.5 mm.; width, 1.6-1.8 mm.

Type and three paratypes.—U.S.N.M. No. 54219.

Geographic distribution.—Localities as follows:

Illinois: State record (1 ♂, type, NMC), northern Illinois 3 ♂♂, 6 ♀♀ (NMC, C. W. Leng collection, Illinois Natural History Survey collection), Edgebrook (2 ♂♂, 3 ♀♀, CASC).

Remarks.—Despite being closely related to *quadrivittata*, *brunnescens* should, I believe, be considered a separate species. It has a strongly alutaceous surface of the elytra—a character not indicated in any of its relatives.

XIII. MOERENS GROUP

This group, containing two closely related species or races, differs from other representatives of *Hyperaspis* inhabiting the United States in having the tarsal claws simple, i.e., devoid of the tooth at the base (pl. 6, fig. 168). For this reason it has been made into a separate genus, *Oxynychus* Leconte. In my opinion, this genus is superfluous. In the first place, the type of the genus, *Oxynychus moerens* Leconte, is evidently closely related to the *annexa* group of *Hyperaspis*. Secondly, the Old World species of *Oxynychus* (*erythrocephalus* Fabr., *alexandrae* Weise) are closer to the *gemma* group of *Hyperaspis* than they are to the *moerens* group. In other words, the simple claws seemingly have arisen independently in otherwise not closely related sections of *Hyperaspis*, and hence *Oxynychus* as now constituted does not represent a natural group. I propose to treat *Oxynychus* Leconte as a synonym of *Hyperaspis* Redtenbacher.

HYPERASPIS MOERENS (Leconte)

PLATE 3, FIGURE 100

Oxynychus moerens LECONTE, in Agassiz, 1850, p. 238.—MULSANT, 1850, p. 694.—LECONTE, 1880, p. 188.—CASEY, 1899, p. 128.
Oxynychus consimilis LECONTE, 1852, p. 134; 1880, p. 189.

Elliptical, pronotum longer in relation to its width than in other species of *Hyperaspis*, elytra broader than the pronotum, evenly arcuate, subdepressed. In males head yellow on the clypeus and black on the vertex, the black part forming a triangular projection at the middle, pronotum with narrow nubilate yellow vittae on lateral margins which are broader anteriorly than posteriorly; in females head black, pronotum with suffused yellow vittae laterally. Elytra black or brownish black with suffused yellow remnants of a marginal vitta which may be broken up into streaks representing the humeral, marginal, and apical spots, and with a suffused yellow discal vitta of varying length, sometimes reduced to a streak at three-quarters of the length of the elytron. Punctulation of the pronotum and the elytra equally dense and strong, interstices not alutaceous. Under side dark piceous, mouth parts, legs, and margins of the abdomen yellowish brown. Prosternal carinae close but almost reaching the anterior margin, femoral lines running for a distance parallel to the posterior margin of the first abdominal sternite, their outer parts rather angular. The middle of the first abdominal sternite with very coarse punctures. Male genitalia unknown. The capsule of the spermatheca rounded, but the connecting duct becoming broader as it approaches the capsule.

Length of the body, 2.3-2.6 mm. ; width, 1.5-1.7 mm.

Geographic distribution.—Localities as follows:

Michigan: Lake Superior (Leconte's type, not examined by the present writer).

Montana: Bear Paw Mountains (NMC).

Wyoming: Yellowstone Park (NMC).

Remarks.—The color scheme in this species is evidently similar to that in species of *annexa* group. The above-described *Hyperaspis oregona borealis* may be mistaken for *moerens*, but the two are easily distinguishable by their body shapes.

HYPERASPIS SIMULANS Casey

Hyperaspis simulans CASEY, 1899, p. 128.

Very similar to the preceding species. Elytra a little more obtusely rounded behind, making the body shape less evenly elliptical. Punctuation of the pronotum somewhat denser than that of the elytra. Elytra black or dark piceous, with or without a suffused yellowish streak marking the location of the humeral spot. Genitalia unknown.

Length of the body, 2.1-2.7 mm. ; width, 1.4-1.8 mm.

Geographic distribution.—Localities as follows:

Arizona: Nogales (type, CC), Palmerlee (NMC), Williams (NMC), Huachuca Mountains (SC).

Remarks.—*H. simulans* and *moerens* are probably only subspecifically distinct, but more material than now available is needed to establish their status.

XIV. SPECIES HAVING NO CLOSE RELATIVES IN THE FAUNA OF THE UNITED STATES

HYPERASPIS BOLTERI Leconte

PLATE 3, FIGURE 95

Hyperaspis bolteri LECONTE, 1880, p. 186.—CASFY, 1899, p. 121.

Oval, little convex, elytra narrower at humeral angles than further caudad, acuminate posteriorly, pronotum considerably longer at the middle than on lateral margins, the distance between its anterior angles being decidedly smaller than between its posterior ones. In males head ochraceous, dark on the vertex, pronotum with rather narrow ochraceous vittae laterally, the anterior margin very narrowly yellowish; in females head and pronotum black. Elytra with a very broad ochraceous orange marginal vitta sharply expanded at three-fifths of the length to form a discal spot broadly fused with the main body of the vitta, which almost reaches the apical part of the suture. Pronotum

strongly alutaceous, punctulation almost obsolete, elytra feebly alutaceous, punctulation dense and moderately strong, punctulation of the under side very dense and coarse on sides of the metasternum, fine elsewhere, on the abdomen almost obsolete. Mouth parts, tibiae and tarsi brownish red, femora dark fuscous. Prosternal carinae almost reaching the anterior margin, femoral lines flat, clearly not reaching the posterior margin of the first abdominal sternite, their outer parts angular. Penis (pl. 5, fig. 134) about as long as the paramera, long and narrow, nearly parallel-sided basally, with an excision on one side and a tubercle on the other in the distal part. The capsule of the spermatheca retort-shaped, the basal portion large, strongly chitinated, with a long appendix.

Length of the body, 3.0-3.1 mm.; width, 2.1 mm.

Geographic distribution.—Localities as follows:

Illinois: Northern part of the State (SC).

Kansas: State record (NMC).

Remarks.—This rare species seems to have no close relatives among the species of *Hyperaspis* known to the writer. It might be placed in the neighborhood of the *taeniata* group, but this is no more than a guess.

HYPERASPIS JOVIALIS Fall

PLATE 2, FIGURE 69

Hyperaspis jovialis FALL, 1925, p. 311.

Broadly oval, rather obtusely rounded behind, moderately convex. In the male head and pronotum whitish yellow, the latter with a black trident pattern in front of the scutellum, the middle prong of the trident being much narrower than the outer ones; in females head and pronotum black, the latter with a whitish-yellow vitta laterally, the length of which is distinctly greater than the width, and the inner boundary of which is uneven. Coloration of the elytra variable; it consists of a cream-colored vitta extending from one-eighth or one-fourth of the length to one-eighth before the apex; the vitta may be broken into a very large discal and a relatively small apical spot; or it may become expanded so that elytra become pale with black margins and a black spot in the posterior third. Punctulation of the pronotum and the elytra moderately dense but very fine, interstices highly polished, shining, that of the under side dense but fine, except on the sides of the metasternum where it is coarse. In the male mouth parts, front and middle legs and tibiae and tarsi of hind legs yellow, in females tibiae and tarsi of all legs brownish yellow. Prosternal carinae

well developed, femoral lines arcuate, their middle parts running parallel to the posterior margin, their outer parts angular and leveled up before reaching the margins of the segment. Genitalia unknown.

Length of the body, 2.4-2.7 mm.; width, 1.7-2.0 mm.

Geographic distribution.—Localities as follows:

California: Kern County, Havilah (type, not examined by the writer), Tulare County (F. T. Scott, SC), Los Angeles County, Big Pines (Th. Dobzhansky), San Bernardino County (F. T. Scott, SC).

Remarks.—This species is superficially similar to *H. leachi*, and hence to the *binotata* group. This is, however, too tenuous a basis to assign to *jovialis* a definite place at present. The variability of the elytral pattern in *jovialis* is remarkable, and may conceivably indicate the presence of two or more geographic races, but here again further material is needed before a decision is reached.

HYPERASPIS CALIFORNICA, new species

PLATE 2, FIGURE 72

Broadly oval, little convex, sides of the elytra feebly arcuate, obtusely rounded behind, head and pronotum relatively short and very broad. In males head yellow, pronotum with light yellow vittae on the lateral and anterior margins, the former about twice as long as wide, sometimes produced for a short distance along the basal margin, the vitta on the anterior margin half as wide as the lateral ones; in females head black, pronotum with lateral yellow vittae only. Elytra with orange-red discal and apical spots; the former rounded or longitudinally oval, located closer to the external margin than to the suture, rather small in the type and much enlarged in one of the cotypes, the apical one transversely oval. Punctulation of the pronotum sparse and obsolescent, that of the elytra slightly denser and very fine, that of the under side dense and fine, coarser on the metasternum. Mouth parts and legs yellow, hind femora fuscous. Prosternal carinae abbreviated, reaching forward to a little more than half of the length of the segment; femoral lines strongly arcuate internally, their external parts on the contrary very flat, forming a very sharp angle with the posterior margin of the first abdominal sternite. Genitalia unknown.

Length of the body, 2.8-3.1 mm.; width, 2.0-2.4 mm.

Type and paratype.—U.S.N.M. No. 54220.

Geographic distribution.—Localities as follows:

California: Mount San Jacinto (Th. Dobzhansky, type, now at NMC); Los Angeles County (Coquillett collection, now in NMC); Claremont (SC); Forest Home, San Bernardino County (E. P. Van Dyke, 3 individuals, CASC).

Remarks.—This species may prove to be an aberrant member of the *binotata* group, but it is less convex than any of its presumed relatives, and the shape of its prosternal carinae and femoral lines is unusual. F. T. Scott's collection contains two individuals (one from Huachuca Mountains, Ariz., D. J. and J. N. Knull, collectors, and the other from Globe, Ariz., collector not stated) which have black elytra and a somewhat stronger punctulation than the California specimens of *californica*, but which otherwise may belong to a separate race of the same species. A formal description of this race is better postponed till more material is available.

HYPERASPIS ESCLAVIUM, new species

PLATE 2, FIGURE 64

Broadly oval, rather strongly convex. In males head yellow, pronotum with subquadrate yellow spots laterally and a yellow anterior margin; in females head black, pronotum with the lateral pale spots only. Elytra with yellow basal, discal, and two apical spots: an inner and an outer one; basal spot large, rounded triangular, with a blunt process toward the suture which it does not reach; discal spot obliquely oval, fused with the arrowhead-shaped inner apical one, the two together forming a spearlike figure; the outer apical the smallest in size, wedge-shaped, the sharp end of the wedge lying near the outer margin and pointed forward; in one of the cotypes the basal spot fused with the discal and inner apical ones to form an arcuate discal vitta. Punctulation of the pronotum and the elytra uniformly dense and strong, that of the under side less strong except on the sides of the metasternum. Mouth parts and legs yellow, the abdomen or its outer edges piccous, in males mesosternal epimera yellowish white. Prosternal carinae long, almost reaching the anterior margin of the segment; femoral lines very broad, their middle parts running for a considerable distance parallel to the posterior margin of the first abdominal sternite, their outer parts strongly angular. Genitalia unknown.

Length of the body, 2.2-2.6 mm.; width, 1.7-2.0 mm.

Type and three paratypes.—U.S.N.M. No. 54221.

Geographic distribution.—Locality as follows:

Mississippi: Biloxi (2 ♂♂, including the type, and 2 ♀♀, C. C. Dean, NMC).

Remarks.—This species has no relatives in the United States, but is probably rather closely related to the common and widespread in the tropical America *H. compedita* Mulsant. I have seen specimens of the latter from Mexico, Morelos, and Mitla (NMC).

HYPERASPIS NUBILATA Casey

Hyperaspis nubilatus CASEY, 1924, p. 166.

Hyperaspis asphaltina CASEY, 1924, p. 166.

Elongate, little convex; head large, relatively short and broad, eyes prominent; pronotum almost as wide between the anterior as between the posterior angles, the sides evenly rounded, the anterior margin straight; sides of the elytra subparallel from the humeral angles to five-sixths of the length, truncate and obtusely rounded behind, the tergite of the last abdominal segment exposed in some individuals, including the type of *asphaltina*. Head brownish black, the clypeus paler in some individuals, pronotum and elytra piceous black, the former sometimes (in ♂♂?) with nubilate pale stripes laterally, the sides of the elytra also with rudiments of nubilous pale marginal vitta. Punctulation of the pronotum rather dense and fine, interstices feebly alutaceous, that of the elytra as dense but stronger, the punctures on the anterior portion tending to form irregular rows, that of the under side dense and rather strong. Under side brown, mesosternum and metasternum piceous black, legs testaceous with infusate hind femora. Genitalia unknown.

Length of the body, 1.7-2.2 mm.; width, 1.2-1.4 mm.

Geographic distribution.—Localities as follows:

North Carolina: Southern Pines (Manee, types and paratypes, CC).

Georgia: Chester (F. Knab collection, now in NMC).

Remarks.—The two species, *nubilata* and *asphaltina*, described by Casey represent in my opinion individual variants of the same form, which is the most peculiar one among the species of *Hyperaspis* known to me, and may in fact deserve being segregated as a separate subgenus or even a genus. I have examined the characters by which the existing genera of *Hyperaspini* are at present separated, and found that from this standpoint *nubilata* must provisionally be classed as a very aberrant *Hyperaspis*.

XV. DOUBTFUL OR INADEQUATELY DESCRIBED SPECIES

The present writer has been unable to identify some of the species described as belonging to the genus *Hyperaspis* among the materials available to him. Some of these species are probably valid and could be with a reasonable certainty identified from their original descriptions, while others, especially those of older authors, are almost beyond doubt synonyms of species otherwise well known. The later category is of interest chiefly in so far as they may cause involved nomenclatorial changes. Since no opportunity of examining the types of these

species is available, their original descriptions are quoted below, with such comment as seems reasonable.

HYPERASPIS ANNULARIS Boheman

Hyperaspis annularis BOHEMAN, 1859, p. 205.

The original description is in Latin; the following is a translation of a part of it.

Pronotum . . . black, shining . . . with the anterior margin narrowly, and the lateral one no more broadly testaceous yellow, the yellow part being continued on either side along the base. Elytra . . . black, shining, with a testaceous yellow lateral margin and a large spot on the posterior part, united in front of the apex with that of the opposite side, this spot including a rather large round black spot. Abdomen with testaceous yellow margins. Legs testaceous yellow.

Geographic distribution.—California.

Remarks.—The elytral color pattern indicated by the above description is very unusual indeed for a species of *Hyperaspis*; unless the genus is misidentified, it must be a very distinctive form.

HYPERASPIS HORNI Crotch

Hyperaspis horni CROTCH, 1873, p. 371.

Female—Closely related to *H. undulata*, but smaller, shorter and rounder, more finely punctate, elytra with a straight margin for two-thirds, a discoidal spot (much nearer the base than in *undulata*), and a triangular sub-apical spot yellow. L. .8 inch. California (Horn).

Remarks.—Leconte (1880, p. 189) believed *horni* Crotch to be a synonym of *lateralis* Mulsant, whereas Casey has at first equated *horni* with *quadrioculata* Motschulsky (1899, p. 128), but later (1908, p. 418) withdrew this opinion. To me, the description of *horni* suggests most *bensonica* Casey, but as the type of the former is unknown, this guess is no safer than the previous ones.

HYPERASPIS NIGROPENNIS Blatchley

Hyperaspis nigropennis BLATCHLEY, 1924, p. 167.

Broadly oval, strongly convex. Black, shining; side margins of thorax above and beneath rather broadly reddish yellow; elytra without spots; front femora except under side, tips of middle and hind ones and all the tibiae and tarsi reddish brown. Entire upper surface finely evenly, rather sparsely punctate. Elytra widest at middle, their tips broadly and bluntly rounded. L. 3 mm. Dunedin, March 28.

HYPERASPIS PLUTO Fall

Hyperaspis pluto FALL, 1925, p. 311.

Suhrotundate, rather strongly convex, entirely black above except for the side margins of the prothorax which are very narrowly reddish yellow. Upper surface polished throughout, with barely perceptible alutaceous sculpture in the clypeal region. Punctuation fine, sparse, and nearly uniform throughout, the punctures separated on the average by about three times their own diameters; a little closer narrowly along the front and the side margins of the thorax. Body beneath black, tarsi and inner face of tibiae more or less rufous; metasternum closely and rather coarsely punctate, ventral segments less densely and more finely punctured, especially at middle. L. 3.75 mm.; W. 3 mm.

Geographic distribution.—Locality as follows:

California: San Bernardino Mountains.

HYPERASPIS SUBSIGNATA Crotch

Hyperaspis subsignata CROTCH, 1874, p. 226.

♂ Hemispherical, ochreous yellow clouded with reddish, clearly shining, punctulate, head yellow, thorax reddish, sides broadly and anterior margin narrowly ochreous, the latter produced posteriorly in the middle; elytra ochreous; the suture and a small spot on the callus reddish. L. $\frac{3}{4}$ -1 lin. Mexico, Campeachy, Texas (Deyrolle). ♀ Head with vertex reddish, thorax with sides only pale, size larger, punctuation finer.

HYPERASPIS TRISTIS (Leconte)

Oxymychus tristis LECONTE, 1880, p. 188.

Claws slender, not dilated at base, body elliptical, less convex than usual; abdomen finely sparsely punctulate. . . . Elytra with a small rounded spot near the tip, and some faint traces of marginal spots; prothorax with narrow yellow side margin; ♂ front yellow; 2 mm.; Colorado (Hardy).

XVI. SPECIES DESCRIBED IN *HYPERASPIS* BUT HERE REMOVED TO OTHER GENERA**HYPERASPIS CAROLINA Casey**

Hyperaspis carolina CASEY, 1924, p. 164.

Examination of the type of this species (Casey's collection, NMC) shows that it belongs to the genus *Brachyacantha* and represents an apparently diminutive specimen of *B. flavifrons* Mulsant.

HYPERASPIS FLORIDANA Mulsant

Hyperaspis floridana MULSANT, 1850, p. 1040.

Crotch (1873, p. 379) believes this to be a species of *Scymnus*, namely, *S. amabilis* Leconte, and his opinion is borne out by the description.

HYPERASPIS SEXUALIS Casey

Hyperaspis sexualis CASEY, 1924, p. 167.

Examination of the type shows that this form belongs to the genus *Scymnus*, the species of which I cannot identify.

HYPERASPIS FALLI Nunenmacher

Hyperaspis falli NUNENMACHER, 1912, p. 450.

HYPERASPIS FLORIBUNDA Nunenmacher

Hyperaspis floribunda NUNENMACHER, 1911, p. 74.

HYPERASPIS WOLCOTTI Nunenmacher

Hyperaspis wolcotti NUNENMACHER, 1911, p. 73.

The above three species, although described as belonging to *Hyperaspis*, are apparently members of the genus *Hyperaspidius* Crotch. Nunenmacher himself in his description of *floribunda* compares it with *Hyperaspidius arcuatus* Leconte, and indicates that *falli* is intermediate between *floribunda* and *simulans* (the latter being, however, a species of *Hyperaspis*). As to *wolcotti*, its description leaves little doubt that a species of *Hyperaspidius* is here involved.

EXPLANATION OF PLATES

All the sketches in these plates represent camera lucida drawings made at magnifications stated below. In so far as possible, the type specimens of various forms have been used, but occasionally the specimens selected proved to be not the most characteristic for a given species or race; thus, in some instances the specimens represented are larger or smaller than the average in size. The majority of individuals represented are males.

PLATE I

- FIG. 1. *Hyperaspis conspirans* Casey (type).
- FIG. 2. *H. fastidiosa fastidiosa* Casey (type).
- FIG. 3. *H. bensonica bensonica* Casey (type).
- FIG. 4. *H. gemma* Casey (type).
- FIG. 5. *H. pratensis medialis* Casey (type).
- FIG. 6. *H. pratensis accumulator* Casey (type).
- FIG. 7. *H. octavia* Casey (type).
- FIG. 8. *H. filiola* Casey (type).
- FIG. 9. *H. quadrioculata fidelis* Casey (type).
- FIG. 10. *H. triangulum* Casey (type, elytra slightly divergent).
- FIG. 11. *H. effeta* Casey (type).
- FIG. 12. *H. tuckeri* Casey (type).
- FIG. 13. *H. elliptica* Casey (type).
- FIG. 14. *H. uniformis* Casey (type).

- FIG. 15. *H. postica* Leconte.
 FIG. 16. *H. subdepressa* Casey (type).
 FIG. 17. *H. proba weisei* Schaeffer (cotype).
 FIG. 18. *H. oculaticauda* Casey (type).
 FIG. 19. *H. protensa* Casey (type).
 FIG. 20. *Hyperaspis taeniata taeniata* Leconte (female).
 FIG. 21. *H. taeniata perpallida*, new variety (type, male).
 FIG. 22. 3-mm. scale applicable to figs. 1-19.
 FIG. 23. *Hyperaspis taeniata pallescens*, new variety (type, female).
 FIG. 24. *H. taeniata significans* Casey (male).
 FIG. 25. *H. taeniata rufescens*, new subspecies (type, male).
 FIG. 26. *H. taeniata cruenta* Leconte (male).
 FIG. 27. *H. taeniata cruentoides*, new subspecies (type, male).
 FIG. 28. *H. pleuralis* Casey (male).
 FIG. 29. *H. osculans* Leconte (male).
 FIG. 30. *H. taeniata binaria* Casey (female).
 FIG. 31. *H. disconotata troglodytes* Mulsant.
 FIG. 32. *H. leachi* Nunenmacher.
 FIG. 33. *H. oregona borealis*, new subspecies (type, male).
 FIG. 34. *H. disconotata canadensis*, new subspecies (type, male).
 FIG. 35. *H. proba proba* (Say).
 FIG. 36. *H. oculifera* Casey (male).
 FIG. 37. *H. revocans occidentalis*, new subspecies (type, male).
 FIG. 38. 3-mm. scale applicable to figs. 20-37.

PLATE 2

- FIG. 39. *Hyperaspis lateralis lateralis* Mulsant (male).
 FIG. 40. *H. lateralis montanica* Casey (male).
 FIG. 41. *H. lateralis flammula* Nunenmacher (male).
 FIG. 42. *H. lateralis nigrocauda*, new subspecies (female, type).
 FIG. 43. *H. lateralis omissa* Casey (male).
 FIG. 44. *H. lateralis wellmani* Nunenmacher (male).
 FIG. 45. *H. excelsa* Fall.
 FIG. 46. *H. taedata* Leconte.
 FIG. 47. *H. pratensis pratensis* Leconte (male).
 FIG. 48. *H. fastidiosa septentrionis*, new subspecies (type).
 FIG. 49. *H. globula* Casey.
 FIG. 50. *H. punctata* Leconte.
 FIG. 51. *H. paludicola* Schwarz.
 FIG. 52. *H. besonica disrupta*, new subspecies.
 FIG. 53. *H. octonotata* Casey.
 FIG. 54. *H. fastidiosa* Casey (male with large spots).
 FIG. 55. *H. chapini*, new species (type).
 FIG. 56. *H. undulata* (Say) (male).
 FIG. 57. *H. quadrioculata quadrioculata* (Motschulsky).
 FIG. 58. *H. quadrioculata scotti*, new subspecies (type).
 FIG. 59. *H. quadrioculata notatula* Casey.
 FIG. 60. *H. spiculinata* Fall.
 FIG. 61. *H. biornata arizonica*, new subspecies.
 FIG. 62. *H. levvati* (Mulsant).

- FIG. 63. *H. revocans revocans* Casey.
 FIG. 64. *H. esclavium*, new species (type, male).
 FIG. 65. *H. disconotata disconotata* Mulsant.
 FIG. 66. *H. rotunda* Casey.
 FIG. 67. *H. connectens* (Thunberg).
 FIG. 68. 3-mm. scale, applicable to figs. 39-72.
 FIG. 69. *H. jovialis* Fall (male).
 FIG. 70. *H. lugubris* (Randall).
 FIG. 71. *H. biornata biornata* Nunenmacher.
 FIG. 72. *H. californica*, new species (type, male, elytra divergent).

PLATE 3

- FIG. 73. *Hyperaspis binotata* (Say) (male).
 FIG. 74. *H. centralis wickhami* Casey (male).
 FIG. 75. *H. bicentralis bicentralis* Casey.
 FIG. 76. *H. lewisi* Crotch (male).
 FIG. 77. *H. haematosticta* Fall.
 FIG. 78. *H. signata* (Olivier).
 FIG. 79. *H. pinorum* Casey (male).
 FIG. 80. *H. gemina* Leconte (female).
 FIG. 81. *H. rivularis*, new species (type, male).
 FIG. 82. *H. centralis plagiata*, new subspecies (type, male).
 FIG. 83. 3-mm. scale applicable to figs. 73-84.
 FIG. 84. *H. bigeminata* (Randall) (male).
 FIG. 85. *H. nunenmacheri* Casey.
 FIG. 86. *H. fimbriolata fimbriolata* Melsheimer.
 FIG. 87. *H. fimbriolata inflexa* Casey.
 FIG. 88. *H. psyche* Casey (an individual more elongate than the mode).
 FIG. 89. *H. fimbriolata serena* Casey.
 FIG. 90. *H. cincta* Leconte.
 FIG. 91. *H. fimbriolata atlantica*, new subspecies (type).
 FIG. 92. *H. sanctae-ritae*, new species (type, male).
 FIG. 93. *H. dissoluta dissoluta* Crotch.
 FIG. 94. *H. dissoluta coloradana* Casey.
 FIG. 95. *H. bolteri* Leconte.
 FIG. 96. *H. annexa* Leconte (male).
 FIG. 97. *H. brunnescens*, new species (type, male).
 FIG. 98. *H. quadrivittata quadrivittata* Leconte (male).
 FIG. 99. *H. oregona*, new species (type, male).
 FIG. 100. *H. moerens* (Leconte) (male).
 FIG. 101. *H. trifurcata* Schaeffer.
 FIG. 102. 3-mm. scale applicable to figs. 85-101.

PLATE 4

- FIG. 103. 0.5-mm. scale applicable to figs. 104 and 106.
 FIG. 104. Reproductive organs of a *Hyperaspis lateralis* male. AG, accessory gland; BP, basal plates; DE, ductus ejaculatorius; P, penis; PA, paramera; S, siphon; SV, seminal vesicles; T, testes; TR, trapes; VD, vas deferens.
 FIG. 105. Penis, basal plates, and paramera of *Hyperaspis fastidiosa fastidiosa* Casey. Significance of letters as in fig. 104.

- FIG. 106. Reproductive organs of a *Hyperaspis lateralis* female. BC, bursa copulatrix; GR, accessory gland of the spermatheca; OD, oviduct; OV, ovaries; RS, spermatheca; 9ST, ninth sternite; 10T, tenth tergite.
- FIG. 107. Outline of the penis of *H. conspirans* Casey.
- FIG. 108. Outline of the penis of *H. gemma* Casey.
- FIG. 109. Outline of the penis of *H. pratensis pratensis* Leconte.
- FIG. 110. Outline of the penis of *H. chapini*, new species.
- FIG. 111. Outline of the penis of *H. lecrati* (Mulsant).
- FIG. 112. Outline of the penis of *H. oculifera* Casey.
- FIG. 113. Outline of the penis of *H. rotunda* Casey.
- FIG. 114. Outline of the penis of *H. excelsa* Fall.
- FIG. 115. Penis, basal plates, and paramera of *H. revocans revocans* Casey.
- FIG. 116. Penis, basal plates, and paramera of *H. connectens* (Thunberg).
- FIG. 117. Outline of the penis of *H. bicentralis bicentralis* Casey.
- FIG. 118. Outline of the penis of *H. signata* (Olivier).
- FIG. 119. Outline of the penis of *H. bigeminata* (Randall).
- FIG. 120. Penis, basal plates, and paramera of *H. lateralis lateralis* Mulsant.
- FIG. 121. Outline of the penis of *H. centralis wickhami* Casey.
- FIG. 122. Outline of the penis of *H. octonotata* Casey.
- FIG. 123. Outline of the penis of *H. binotata* (Say).
- FIG. 124. Outline of the penis of *H. haematosticta* Fall.
- FIG. 125. 500- μ scale applicable to figs. 105, 107-124.

PLATE 5

- FIG. 126. Penis, basal plates, and paramera of *Hyperaspis undulata* (Say).
- FIG. 127. Outline of the penis of *H. paludicola* Schwarz.
- FIG. 128. Outline of the penis of *H. octavia* Casey.
- FIG. 129. Outline of the penis of *H. punctata* Leconte.
- FIG. 130. Outline of the penis of *H. quadrioculata quadrioculata* (Motschulsky).
- FIG. 131. Outline of the penis of *H. disconotata disconotata* Mulsant.
- FIG. 132. Outline of the penis of *H. trifurcata* Schaeffer.
- FIG. 133. Outline of the penis of *H. spiculifera* Fall.
- FIG. 134. Outline of the penis of *H. bolteri* Leconte.
- FIG. 135. Outline of the penis of *H. simulatrix*, new species.
- FIG. 136. Outline of the penis of *H. bensonica bensonica* Casey.
- FIG. 137. Penis, basal plates, and paramera of *H. postica* Leconte.
- FIG. 138. Outline of the penis of *H. dissoluta dissoluta* Crotch.
- FIG. 139. Outline of the penis of *H. cincta* Leconte.
- FIG. 140. Outline of the penis of *H. fimbriolata inflexa* Casey.
- FIG. 141. Outline of the penis of *H. fimbriolata atlantica*, new subspecies.
- FIG. 142. Outline of the penis of *H. sanctae-ritae*, new species.
- FIG. 143. Outline of the penis of *H. psyche* Casey.
- FIG. 144. Penis, basal plates, and paramera of *H. fimbriolata fimbriolata* Melsheimer.
- FIG. 145. Penis, basal plates, and paramera of *H. proba proba* (Say).
- FIG. 146. Penis, basal plates, and paramera of *H. biornata* Nunenmacher.
- FIG. 147. Outline of the penis of *H. oregona*, new species.
- FIG. 148. Outline of the penis of *H. annexa* Leconte.
- FIG. 149. Outline of the penis of *H. quadrivittata quadrivittata* Leconte.
- FIG. 150. Penis, basal plates, and paramera of *H. globula* Casey.
- FIG. 151. 500- μ scale applicable to figs. 126-150.

PLATE 6

- FIG. 152. Penis, basal plates, and paramera of *Hyperaspis lugubris* (Randall).
 FIG. 153. Outline of the penis of *H. munimacheri* Casey.
 FIG. 154. Outline of the penis of *H. taeniata cruenta* Leconte.
 FIG. 155. Outline of the penis of *H. taeniata nevadica* Casey.
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 FIG. 158. Spermatheca of *H. trifurcata* Schaeffer.
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 FIG. 161. Penis, basal plates, and paramera of *H. pleuralis* Casey.
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 FIG. 163. Spermatheca of *H. proba proba* (Say).
 FIG. 164. Spermatheca of *H. globula* Casey.
 FIG. 165. Spermatheca of *H. binotata* (Say).
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 FIG. 170. Maxillae and labium of *H. lateralis* Mulsant.
 FIG. 171. 500- μ scale applicable to figs. 152-166.
 FIG. 172. 500- μ scale applicable to figs. 167-170.

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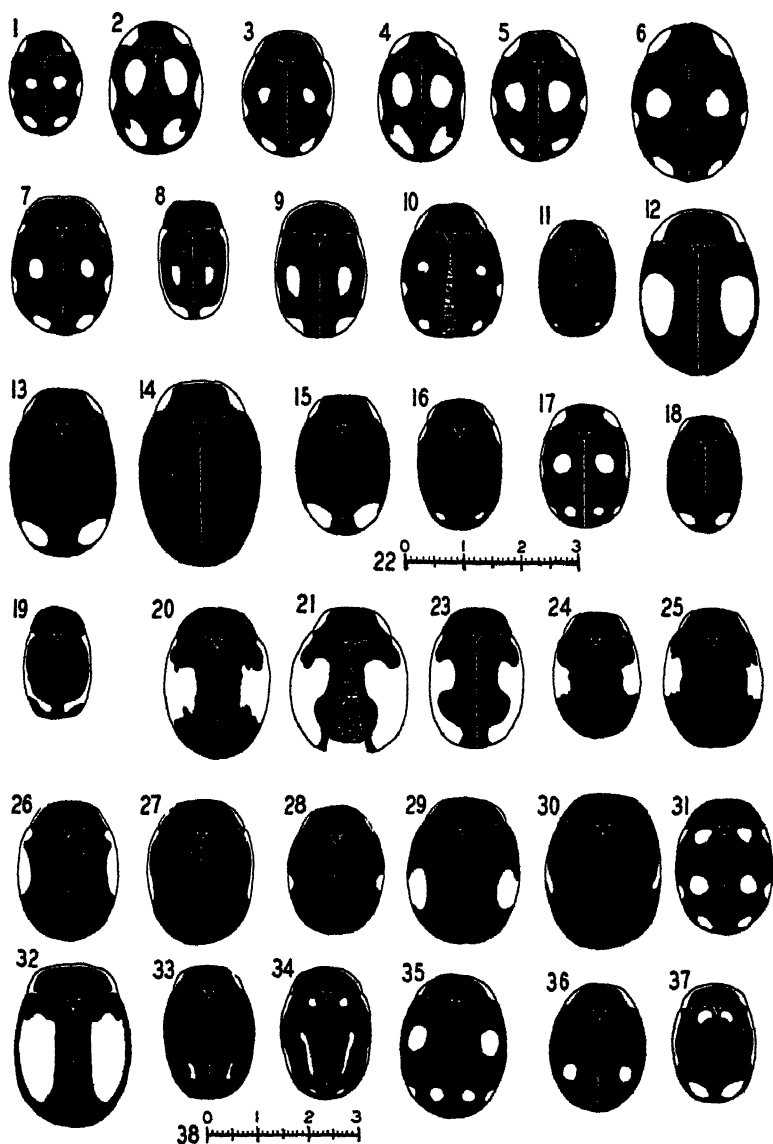
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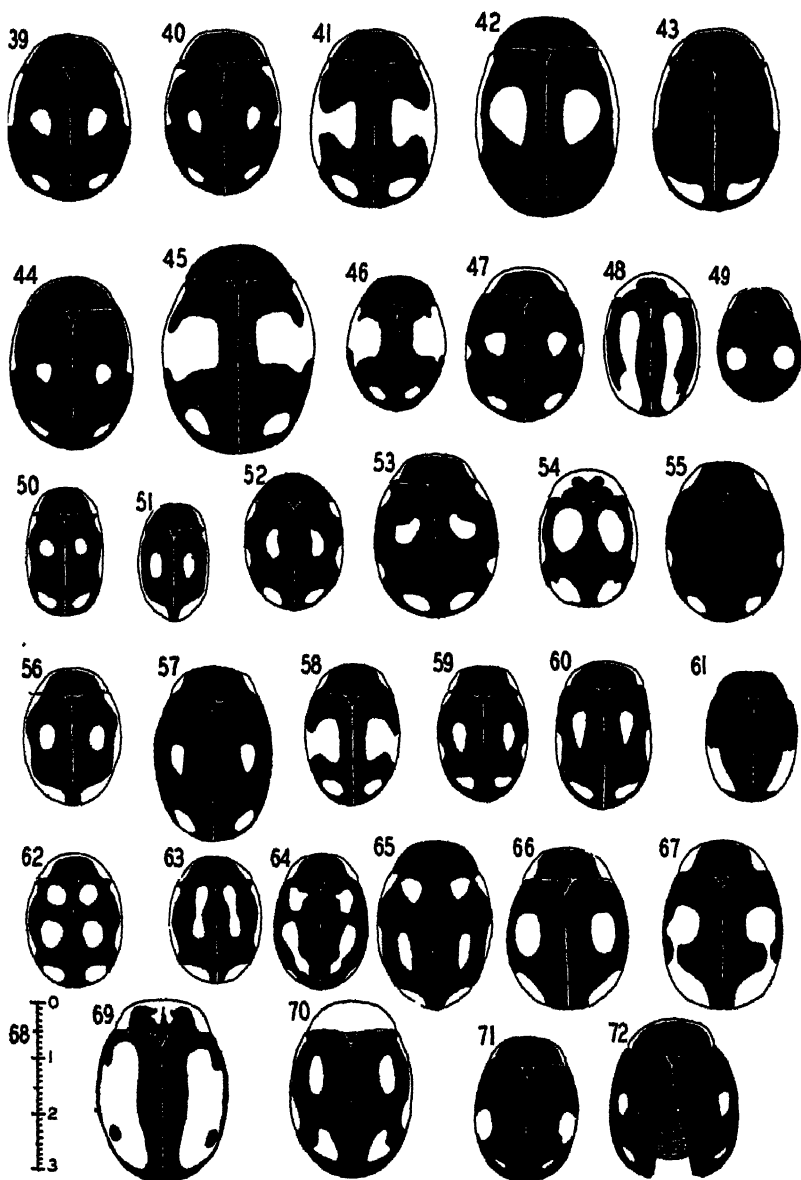
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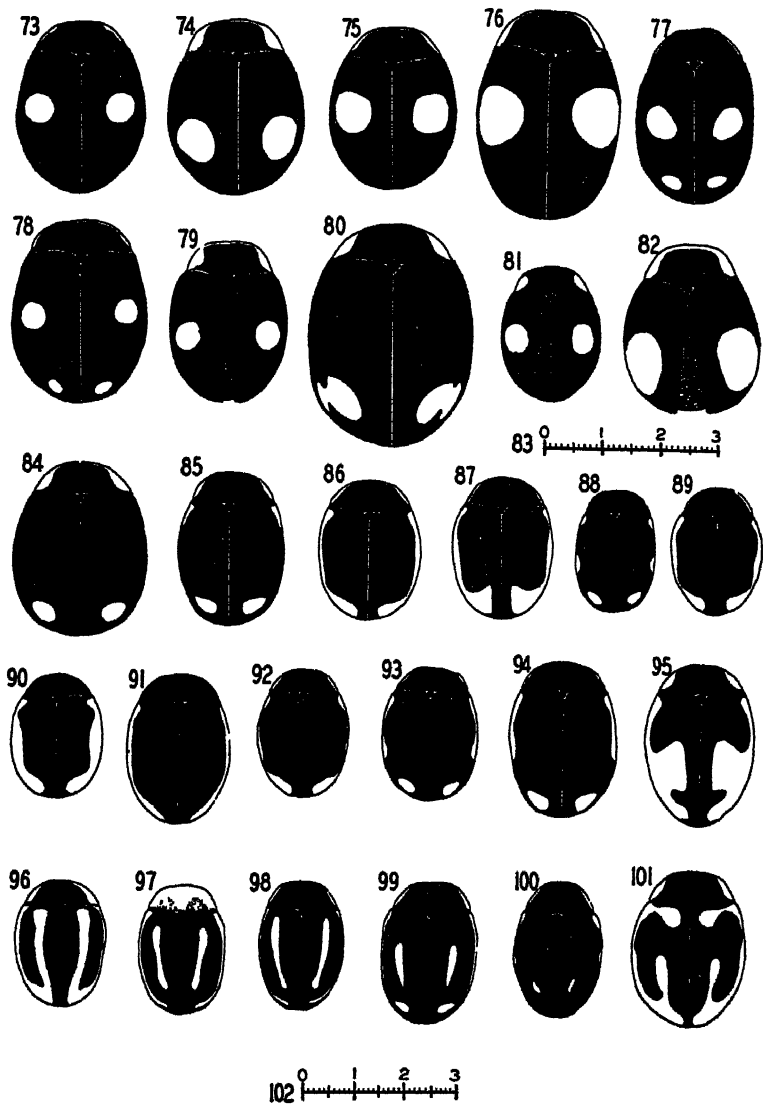
BEETLES OF THE GENUS *HYPERASPIS* INHABITING THE UNITED STATES

(For explanation of plate see pages 86-87.)

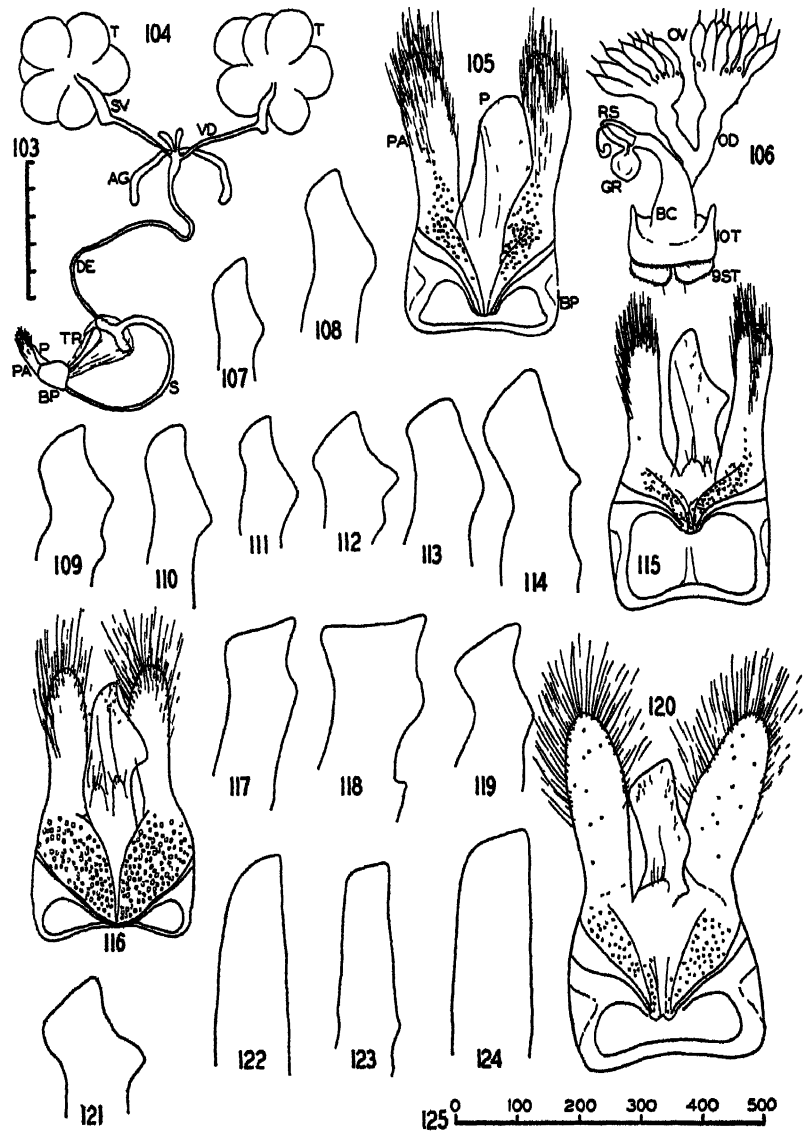


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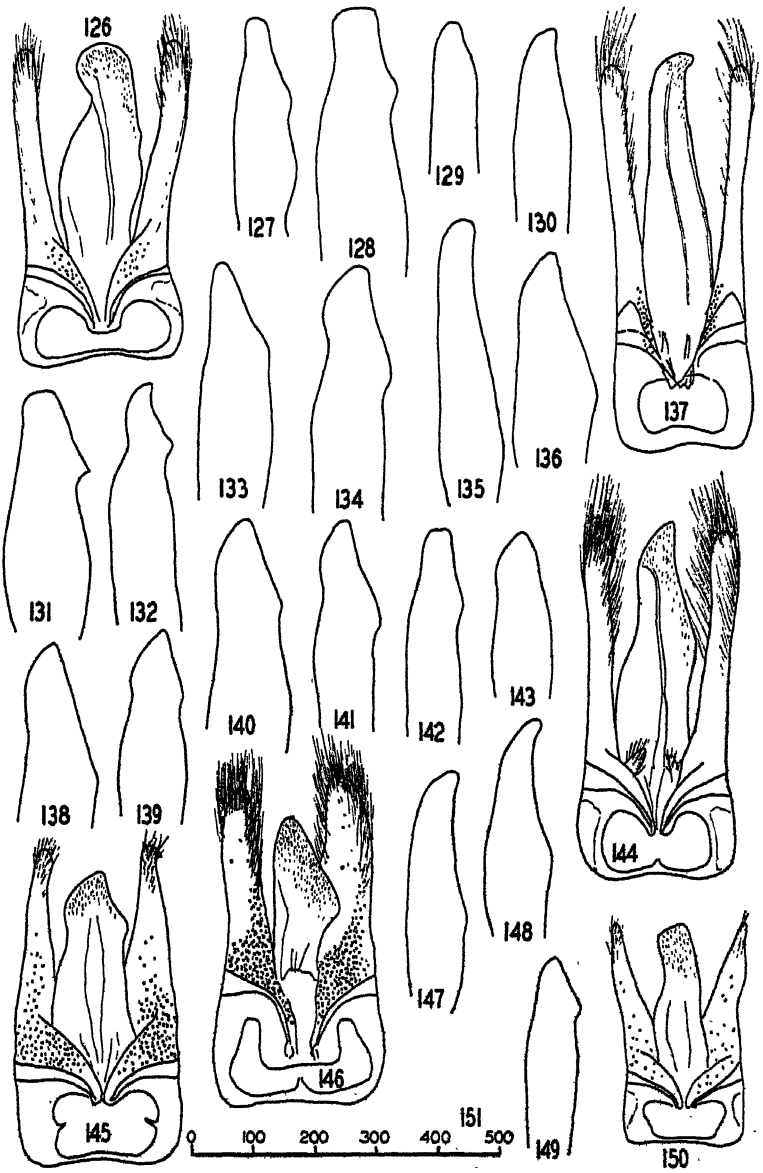
(For explanation of plate see pages 87-88.)



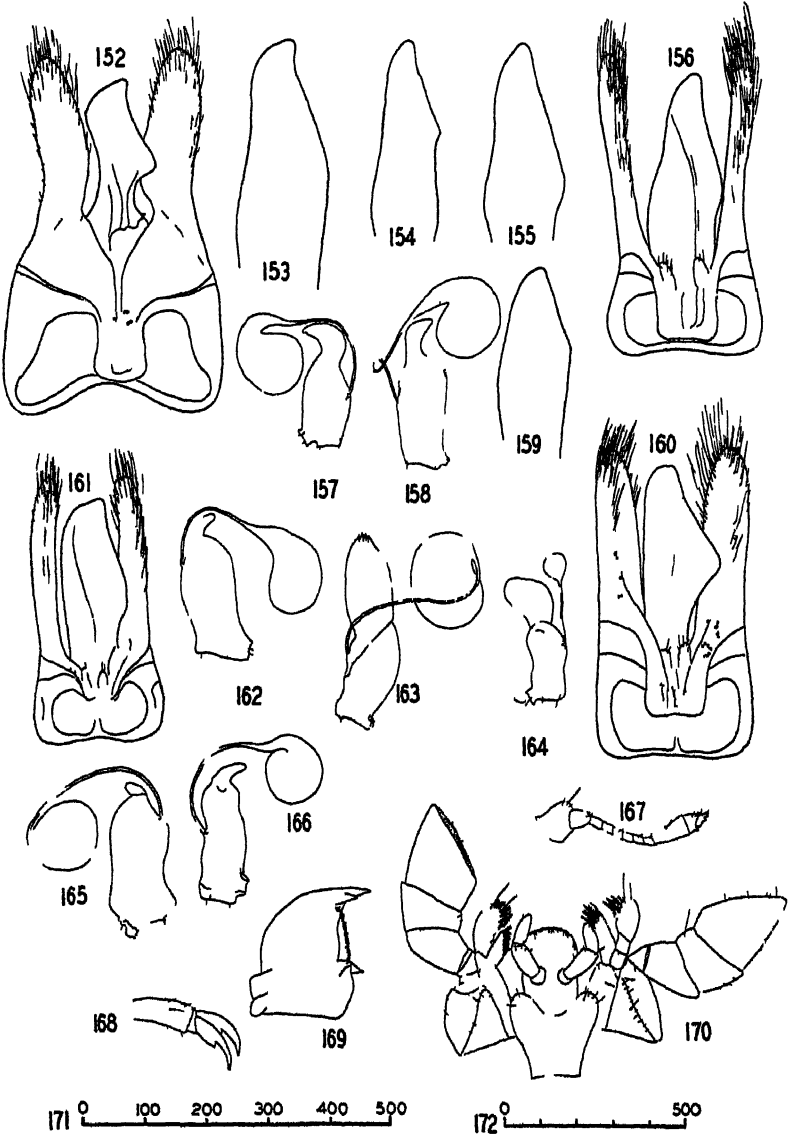
BEETLES OF THE GENUS *HYPERASPIS* INHABITING THE UNITED STATES
(For explanation of plate see page 88.)



BETLES OF THE GENUS *HYPERASPIS* INHABITING THE UNITED STATES
(For explanation of plate see pages 88-89.)



BEETLES OF THE GENUS *HYPERASPIS* INHABITING THE UNITED STATES
(For explanation of plate see page 89.)



BETLES OF THE GENUS *HYPERASPIS* INHABITING THE UNITED STATES
(For explanation of plate see page 90)

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VOLUME 101, NUMBER 8

BEEES OF THE FAMILY HYLAEIDAE FROM THE ETHIOPIAN REGION

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By T. D. A. COCKERELL

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INTRODUCTION

The bees now recorded are a part of a collection received from the British Museum, to which they will be returned after the war. The hylaeid bees, with short tongues, are considered primitive, and yet are differentiated into numerous groups showing striking modifications. As V. B. Popov, of Leningrad, has recently set forth in some detail, the holarctic species can be divided into a considerable number of groups or subgenera. In Australia and Africa, however, there is much more diversity, and no one has questioned the recognition of several Australian genera, the characters of which are (with the exception of some more recently described) set forth by Meade-Waldo in *Genera Insectorum*, 1923. However, the species usually referred to *Prosopis* or *Hylaeus* are themselves diverse and will no doubt eventually be split up into a series of genera. J. C. Bridwell (Proc. Hawaiian Ent. Soc., vol. 4, June 1919) has made a beginning of this as regards the African species, recognizing a new genus *Nothylaeus* for the species *heraldicus*, *junodi*, *braunsi*, *rubrifacialis*, *sansibaricus*, *nyassanus*, *binotatus*, *magretti*, *gigas*, *peringueyi*, and *yoruba*. *Anylaeus* is a new subgenus of *Nothylaeus* for *aberrans* and *dentiferellus*. *Metylaeus* is a new genus for *cribratus*, *catalauncoides*, and *scutispina*. *Deranchylaeus* is a new subgenus of *Hylaeus*, including the rest of the species of the Ethiopian region. Thus while in the related family Colletidae true *Colletes* is well represented in South Africa, the Ethiopian region has a peculiar hylaeid fauna of its own, although it is not so distinct as that of Australia.

In working over these bees, I have not found it easy to classify them into genera and subgenera and so have recorded as *Hylaeus* numerous species which do not belong to that genus in the restricted sense. Following and extending the methods of Bridwell, some student should reclassify the Hylaeidae of the world, including the numerous African species which were unknown to Bridwell. This undertaking is not now possible, owing to the disturbed condition of

the world, and in any case it will be difficult to assemble in any one place a sufficient collection for the purpose.

I give a list of the names proposed for African species (excluding those of the Palaearctic portion), and a key to the separation of the species discussed in this paper.

NAMES PROPOSED FOR AFRICAN SPECIES

Those marked with an asterisk are described or recorded in the present paper.

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|---|---|
| <i>aberrans</i> Bridwell, 1919 | * <i>immarginatus</i> Alfken, 1914 |
| <i>abjunctus</i> Cockerell, 1936 | * <i>junodi</i> Friese, 1911 |
| <i>absomulus</i> Cockerell, 1936 | <i>rufipedoides</i> Strand, 1911 |
| <i>albonasatus</i> Strand, 1912 | * <i>junodi montacuti</i> , new variety |
| <i>alfkeni</i> Friese, 1913 | * <i>junodi rhodesicus</i> , new subspecies |
| <i>xanthopus</i> Alfken, 1914 | <i>kasindensis</i> Cockerell, 1936 |
| * <i>ameliae</i> , new species | <i>krebsianus</i> Strand, 1912 |
| <i>arnoldi</i> Friese, 1913 | <i>leucolippus</i> Friese, 1913 |
| * <i>aterrimus</i> Friese, 1911 | <i>libericus</i> Cockerell, 1936 |
| <i>quinquedeniatus</i> Friese | <i>lightfooti</i> Bridwell, 1919 |
| <i>atriceps</i> Friese, 1911 | <i>lineaticeps</i> Friese, 1913 |
| <i>atriceps major</i> Strand, 1912 | * <i>magnificus</i> , new species |
| <i>bequaertianus</i> Bridwell, 1919 | <i>magretti</i> Vachal, 1892 |
| <i>bevisti</i> Cockerell, 1917 | * <i>melanosoma</i> Cockerell, 1920 |
| <i>binotatus</i> Alfken, 1914 | * <i>microstictus</i> , new species |
| <i>braunsi</i> Alfken, 1905 | * <i>namaquensis</i> , new species |
| <i>braunsi fumata</i> Strand, 1912 | * <i>neavei</i> , new species |
| <i>braunsi nigricans</i> Friese, 1913 | <i>nyassanus</i> Strand, 1912 |
| <i>buyssoui</i> Vachal, 1899 | <i>ogilviei</i> Cockerell, 1932 |
| * <i>capicola</i> Alfken, 1914 | * <i>perater</i> Cockerell, 1936 |
| <i>catalauides</i> Bridwell, 1919 | <i>perdensus</i> Cockerell, 1936 |
| <i>clavigera</i> Cockerell, 1936 | <i>peringueyi</i> Bridwell, 1919 |
| <i>cribratus</i> Bridwell, 1919 | * <i>pondonis</i> , new species |
| * <i>curvicarinatus</i> Cameron, 1905 | <i>promontorii</i> Meade-Waldo, 1923 |
| <i>robertianus</i> Cameron, 1906 | <i>longulus</i> Friese, 1913 (preoccupied) |
| * <i>dentiferellus</i> Strand, 1912 | * <i>proteae</i> , new species |
| <i>dregei</i> Strand, 1912 | <i>punctiferus</i> Cockerell, 1936 |
| * <i>flaviscutum</i> Alfken, 1914 | <i>reditus</i> Cockerell, 1936 |
| <i>vau</i> Cockerell, 1936 | <i>rhodognathus</i> Cockerell, 1936 |
| <i>fortis</i> Cockerell, 1936 | <i>rubrifascialis</i> Strand, 1912 |
| <i>gabonicus</i> Vachal, 1899 | <i>rugiceps</i> Friese, 1921 |
| <i>gaullei</i> Vachal | <i>rugipuncta</i> Alfken, 1914 |
| <i>gigas</i> Friese, 1911 | <i>sanctus</i> Cockerell, 1936 |
| <i>graaffi</i> Cockerell, 1936 | <i>sansibaricus</i> Strand, 1912 |
| <i>haygoodi</i> Bridwell, 1919 | <i>scutispina</i> Alfken, 1914 |
| <i>heraldicus</i> Smith, 1853 | <i>simplex</i> Bingham, 1923 |
| <i>abyssinica</i> Alfken, 1905 | <i>simplicior</i> Meade-Waldo, 1923 |
| <i>rubriplagiatus</i> Cameron, 1905 | * <i>simpsoni</i> , new species |
| <i>heraldicus maculipes</i> Cockerell, 1936 | * <i>simulans</i> , new species |
| <i>heraldicus rufipictus</i> Strand, 1912 | * <i>subfortis</i> , new species |

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|--|------------------------------------|
| <i>sublucens</i> Cockerell, 1936 | <i>uelleburgensis</i> Strand, 1912 |
| * <i>subreductus</i> , new species | <i>ugandicus</i> Cockerell, 1939 |
| <i>tenuis</i> Alfken, 1914 | * <i>umtalicus</i> Cockerell, 1936 |
| <i>tenuis dominae</i> Cockerell, 1936 | <i>varians</i> Cockerell, 1936 |
| <i>tinctulus</i> Cockerell, 1932 | * <i>xanthostoma</i> Alfken, 1914 |
| <i>tinctulus extensicornis</i> Cockerell, 1936 | <i>yoruba</i> Bridwell, 1919 |

KEY TO SPECIES DISCUSSED IN THIS PAPER

- Abdomen at least partly red.....1
 Abdomen not at all red.....10
1. Clypeus yellow or yellowish white, the lateral margins sometimes dark.....2
 Clypeus with middle third, or not much more, yellow.....7
2. Scutellum entirely black; legs and tegulae red.....*neavei*, new species
 Scutellum with light spots.....3
3. Small species; face marks yellowish white; postscutellum with two teeth...4
 Larger species; face marks yellow; postscutellum unarmed.....5
4. First tergite almost entirely red (*Okahandja*).....*dentiferellus* Strand
 First tergite black, red only at sides (*Durban*).....*dentiferellus* Strand
5. Supraclypeal mark a little broader than long
 junodi rhodesicus, new subspecies, female
 Supraclypeal mark much longer than broad.....6
6. Lower end of lateral marks contiguous with clypeal yellow
 junodi rhodesicus, new subspecies, male
 Lower end of lateral marks well separated from clypeal yellow
 junodi Friese, male
7. Mesonotum red; no light spots on scutellum.....*simpsoni*, new species
 Mesonotum black8
8. Second abdominal tergite red; sides of clypeus red
 junodi rhodesicus, new subspecies
 Second tergite black, the first red.....9
9. Supraclypeal mark higher than broad.....*junodi v. montacuti*, new variety
 Supraclypeal mark not higher than broad.....*junodi* Friese
10. Abdomen steel blue.....*magnificus*, new species
 Abdomen black11
11. Face with three light stripes.....12
 Face all light.....15
 Clypeal region and mouth red.....*xanthostoma* Alfken
 Clypeus black, or with a minute light spot.....27
12. Supraclypeal mark present; larger species.....13
 Supraclypeal mark absent; smaller species.....14
13. With paired spines on abdomen.....*aterrimus* Friese
 Without such spines.....*pondonis*, new species
14. Clypeus with a large cuneiform white mark.....*capicola* Alfken
 Clypeus with only a light stripe.....*capicola* Alfken
15. Larger species, about 10 mm. long.....16
 Much smaller18
16. Lateral face marks elongate and attenuate above; face pale yellow
 fortis Cockerell
 Lateral face marks shorter, not attenuate above; face chrome yellow.....17

17. A conspicuous black stripe at each side of clypeus.....*ugandicus* Cockerell
Only a black dot at each side of clypeus.....*subfortis*, new species
18. Supraclypeal mark present; scutellum with two light marks
ameliae, new species
Supraclypeal mark present; scutellum without light marks.....19
Supraclypeal mark absent; scutellum without light marks..... 23
19. Larger; face orange.....20
Smaller; face white or very pale yellow.....21
20. Upper level of orange deeply excavated at insertion of antennae
namaquensis, new species
Upper level of orange nearly even.....*umtalicus* Cockerell
21. Upper extension of lateral marks broad; flagellum bright red beneath
curvicaarinatus Cameron
Upper extension of lateral marks slender; flagellum dusker red.....22
22. Wings distinctly dusky.....*subreditus*, new species
Wings clear*flaviscutum* Alfken (*van* Cockerell)
23. Light color of clypeus extending above inner level of lateral marks, simulating a supraclypeal mark.....*immarginatus* Alfken
Light color of clypeus not so extending.....24
24. Light color of clypeus level with inner corners of lateral marks
immarginatus Alfken
Light color of clypeus not thus level.....25
25. Legs, at least basitarsi, largely yellow; very near *H. varians*, but clypeus much shorter (Port St. John).....species
Legs not at all yellow.....26
26. Smaller, face narrower; upper end of lateral marks slender (Durban, F. Muir)species
Larger, face broader (Mossel Bay, Turner)species
27. Face black, with a large triangular light mark at each side
namaquensis, new species, female
With large lateral marks on upper part of face, and a triangular supraclypeal mark*proteae*, new species
Lateral face marks linear, punctiform, or absent.....28
28. Face entirely black in both sexes; scape of male swollen (Abyssinia to S. Rhodesia)*perater* Cockerell
Clypeus with a large shining pit (female)29
Clypeus without such a pit.....30
29. Collar with conspicuous light margin.....*microstictus*, new species
Collar all black; face marks very weak.....*subreditus*, new species
30. Smaller; face marks linear, well developed.....*flaviscutum* Alfken
Larger; face marks reduced to small spots, or absent; wings dusky
melanosoma Cockerell

There is a residue of small dark-faced females, collected by Turner, as follows:

- Lateral marks linear, well developed.....1
Lateral marks reduced to small spots or absent.....3
1. Collar black (as in *H. flaviscutum*) (Swellendam).....sp.
Collar yellowish white.....2

2. Tubercles partly white (Port St. John, Turner, 9).....sp.
Tubercles black (Katberg) (Turner, 7).....sp.
3. (Smaller than *H. melanosoma*, and with clear wings)
Front dull (Katberg; Mossel Bay).....sp.
Sides of front shining (Worcester; Matjesfontein).....sp.

The unnamed species in this key are, with the exception of the last two, represented by single specimens, and they are best left unnamed for the present. They are all small, without striking characters.

NOTHYLAEUS SUBFORTIS, new species

Male.—Length about 10.5 mm.; robust, black, with no red, and no light marks on scutellum; labrum black, mandibles obscurely reddish at end; face pale lemon yellow, shining, the yellow including clypeus, supraclypeal mark (which is hat-shaped, narrowed and truncate, not at all notched, above), and lateral marks, which form broad triangles with the base on orbit, and the inner sides about equal; frontal keels strong, somewhat arched outward; antennae entirely black; mesonotum dull, very coarsely punctured; scutellum moderately shining, with very large punctures, and a strong median groove; area of metathorax with very coarse irregular rugae; pronotum with two widely separated yellow spots above, and a large part of tubercles yellow; tegulae black; wings dilute fuliginous; basal nervure falling short of nervulus; first recurrent joining first cubital cell some distance from end, second recurrent going very slightly beyond outer intercubitus; legs black, the front tibiae and small joints of hind tarsi a little reddish; abdomen very finely punctured, the apical margin of first tergite, and all of second, shining; no hair bands; third sternite with a strong curved transverse callus.

East Africa: 150-200 miles west of Kambove, 3,500-4,500 feet, October 15, 1907 (S. A. Neave).

Closely allied to *N. fortis* Cockerell, but differing by the broader, more shining face, its color more orange, the lateral face marks less attenuated above; the mesonotum more robust and more coarsely sculptured. *N. fortis* was described from the Belgian Congo, but Neave took three in the Bugoma Forest, Uganda, 3,700 feet, December 1-5, 1911; and in the Mabira Forest, Chagwe, Uganda, 3,500-3,800 feet, July 1911, he took one *N. fortis* and one *N. ugandicus* (Cockerell). I described *N. ugandicus* under *Hylaeus*, and suggested at the time that *N. fortis* should also be so referred. As more species come to light, it is hard to define the genera precisely, but certainly those insects are nearer to *Nothylaeus* than to typical *Hylaeus*.

4. Supraclypeal mark higher than broad (Montagu)
 junodi (Friese), male, var. *montacuti*, new variety
 Supraclypeal mark not higher than broad.....5
5. Clypeal mark greatly broadened at lower end (Mossel Bay)
 junodi (Friese), female
 Clypeal mark not broadened at lower end (Queenstown, Ceres, Mossel
 Bay)junodi (Friese), female

The Montagu *N. junodi* male, taken by Turner in September, has the face marks cream color, and the clypeus with a broad black band down each side; the marks on scutellum are rather widely separated. The third sternite of the abdomen has a strong transverse thickening, of which there are only faint indications in the other *N. junodi*.

N. junodi was originally based on the female, from Shilouvane in the Transvaal. Strand's *N. rufipedoides* (not *rufipedioides*, as Bridwell has it) appears to be the same, so far as the description shows. He had males from "Kapland" and a female from Langenburg, Lake Nyasa.

NOTHYLAEUS DENTIFERELLUS (Strand)

This was described from a male from Delagoa Bay. The first abdominal segment is described as red, with the sides of the dorsum blackened. Three taken by Turner at Okahandja, on the opposite side of the continent, have the middle of the dorsum blackened posteriorly. One from Durban, Natal, July 31, 1916 (C. M. Barker), has the first tergite black except at extreme sides, where it is red. More material may suggest the recognition of one or more subspecies.

HYLAEUS UMTALICUS (Cockerell)

Nyasaland; Mlanje, May 24, 1913, one male (S. A. Neave).

This was described under *Nothylæus*, but the mandibles are not as in that genus. The present specimen differs from the type in the clearer wings, and the first recurrent nervure ending some distance before the end of first cubital cell.

HYLAEUS AMELIAE, new species

Male.—Length about 4 mm., anterior wing a little over 3 mm.; black, with face, collar (interrupted in middle), tubercles, and two transverse marks on scutellum creamy white; clypeus long; supra-clypeal mark well developed, subquadrate, extending between antennae; lateral face marks broad above, ending in a point on orbital margin halfway up front; antennae ferruginous, dusky above; scape pyriform; a smooth shining band at outer side of lateral ocelli;

mesonotum dull, very coarsely punctured; area of metathorax very coarsely sculptured, the ridges shining; tegulae pale red, with a white spot; wings hyaline, faintly dusky, stigma and nervures brown; basal nervure falling a little short of nervulus, first recurrent nervure joining first cubital cell not far from end; legs red with a blackish suffusion, front legs with a large white mark on basal half, and the basitarsi white; abdomen mainly dull, but first tergite polished; hind margins of first two tergites with fringes of white hair, interrupted in middle.

Portuguese East Africa: Porto Amelia (F. V. Beste).

Perhaps to go in *Nothylaeus*, but not a typical member of that genus. It will be known by the very small size, wherein it resembles *H. melanosoma* (Cockerell), but the antennae are not as long as in that species, and the markings are very different. From various small species it is known by the spots on the scutellum. The microscope shows that the supraclypeal mark is trilobed at upper end, and the mandibles are red. The trilobed upper end of supraclypeal mark recalls *H. dentiferellus* (Strand).

HYLAEUS MICROSTICTUS, new species

Female.—Length nearly 7 mm.; black, including legs, but with white markings as follows, rather broad bands along inner orbits, the lower end about level with lower end of eye, the upper rather less than halfway up front, strong band on collar, interrupted in middle, and large spot on the otherwise black tegulae; tubercles black, the margin ciliate with short white hairs; flagellum obscure reddish beneath; face broad; clypeus with a shining transverse well-defined semilunar depression, and on each side of it an obtuse longitudinal ridge; front dull; vertex a little shining, well punctured; mesonotum and scutellum dullish (not at all polished), very closely and minutely punctured; metathorax entirely dull, the area rugulose; wings dusky, stigma and nervures brown; basal nervure meeting nervulus; first recurrent ending some distance before end of the very long first cubital cell; abdomen shining, with a short band of white hair sublaterally on each side of margin of first and second tergites; first tergite very finely punctured.

Cape Province; Mossel Bay, March-April 1930, and October 26-31, 1933, three specimens (R. E. Turner, 7, in part).

Belongs to the *H. dregei* group, and is easily distinguished by the finely punctured first tergite, white band on collar, dusky wings, and black tubercles. *H. lineaticeps* (Fries), of which I possess only the

male, has yellow markings, and the thorax above evidently shining. The female *H. lineaticeps* has the collar entirely black.

HYLAEUS CURVICARINATUS (Cameron)

Cape Province: Swellendam, November 1933, 3 males (R. E. Turner).

HYLAEUS NEAVEI, new species

Male.—Length about 9 mm.; robust, black, with the face dull pale orange, and the sides and base of first tergite broadly red; the tubercles, legs, extreme apex of abdomen, and subapical region beneath, also red; tegulae shining clear red; wings clear hyaline, stigma dilute brown. Face broad; supraclypeal mark quadrate, broader than long; lateral marks attenuate above, coming to a sharp point not on orbit; antennae red, the flagellum dusky above; mesonotum dullish, coarsely punctured; scutellum shining between the large punctures, contrasting with mesonotum; area of metathorax coarsely wrinkled, but shining; posterior face of metathorax with a conspicuous shining channel in middle; basal nervure falling short of nervulus; first recurrent meeting intercubitus; second recurrent joining second cubital cell a little before end; abdomen dullish; first tergite with an apical band of white tomentum on each side; third sternite with a pair of sublateral ridges; sixth red, with prominent corners.

East Africa: Southeast slopes of Mount Kenya, 6,000-7,000 feet, February 3-12, 1911 (S. A. Neave).

Closely allied to the much smaller *bevisi* (Cockerell), from Natal, but the mesonotum is much more coarsely punctured than in that insect. These bees should perhaps go in *Nothylaeus*.

HYLAEUS MAGNIFICUS, new species

Male.—Length about 9.5 mm.; rather slender, with long antennae; head, thorax, abdomen, femora, and tibiae bright steel blue, or perhaps better described as purple; mouth parts typical for *Hylaeus*; clypeus with a large conical creamy-white mark, varying much in size; antennae black, the flagellum obscurely brownish beneath; thorax without light markings; mesonotum dull and finely punctured; scutellum more shining, but still finely punctured; area of metathorax large, poorly defined, appearing rugulose; tegulae purple; wings variably dusky, sometimes quite dark; basal nervure falling a little short of nervulus; first recurrent nervure joining first cubital

cell a variable distance from end; abdomen shining, without hair bands; venter simple.

East Africa: East foot and slopes of Aberdare Mountains, 7,000-8,500 feet, February 24-27, 1911 (S. A. Neave).

Very distinct by its purple color, which recalls some of the Australian Hylaeidae. Four specimens were collected.

HYLAEUS ATERRIMUS (Friese)

Pondoland: Port St. John, two females, October 1923, one male January 1924. (R. E. Turner, 3).

One female is labeled "on *Protea*, 1,200 feet." I have female *H. aterrimus* from Bulawayo and Hope Fountain, South Rhodesia, from the Rhodesia Museum.

HYLAEUS PONDONIS, new species

Male.—Length about 7 mm.; in most respects exactly like *H. aterrimus*, but less robust; the third sternite with a strong dentiform process in the middle, but the paired processes, above and below, entirely lacking; pale clypeal band very slender, its upper end not nearly as wide as base of supraclypeal mark; lateral face marks more slender above; scutellum more shining.

Pondoland: Port St. John, October 1923 (R. E. Turner).

According to Alfken, and I believe correctly, the *Prosopis quinquedentata* Friese is to be considered the true male of *H. aterrimus*. The male which Friese doubtfully referred to *H. aterrimus* is probably *H. pondonis*. But it will be noticed that at Port St. John, Turner took female *H. aterrimus* and male *H. pondonis* in October; male *aterrimus* (agreeing with *Prosopis quinquedentata*) in January. Is it possible that we have two species, easily separated in the male, but alike in the female sex?

HYLAEUS CAPICOLA (Alfken)

Male.—About 4.5 mm. long; black, with very long antennae, the flagellum obscurely reddish beneath; eyes large, and orbits strongly converging below; clypeus dull white, with a broad black band down each side; no supraclypeal mark; lateral face marks well developed, but narrow, bandlike, widely separated from clypeal mark; labrum and mandibles black; mesonotum finely punctured, somewhat shining; no light markings on thorax; tegulae black; wings grayish, iridescent; legs black, tarsi brownish, a light stripe on front tibiae; abdomen narrow, shining.

Female.—About 6.5 mm. long; clypeus with a slender median stripe; lateral marks long slender bands, not diverging from orbits; collar yellowish white, and tubercles margined with the same color; first and second tergites with slight marginal hair bands at sides. The flagellum is obscure brown beneath. The stigma is black, and the nervures are dark.

Pondoland: Port St. John, females, January, April, and May, 1924; male, June 1923 (Turner).

The male resembles *H. melanosoma* (Cockerell) closely, differing by the broad black band along each side of clypeus. The female is easily known from *H. melanosoma* by the three stripes on face. Alfken knew only the female.

HYLAEUS SIMPSONI, new species

Female.—Length about 8 mm.; robust, head (including antennae), thorax, abdomen, and legs light ferruginous; face marks dull cream color, as follows: broad median stripe on clypeus, broadest at upper end, supraclypeal mark, broader than long, long but narrow lateral face marks, extending far up sides of front, and a small transverse mark on each side of clypeus near margin, contiguous with the lower end of clypeal mark (which is curved under eye), but not reaching median band; collar pale yellow, but tubercles red; scutellum without light marks; mandibles shining, very broad, the apex sharply pointed but not much elongate; front and mesonotum dull, scutellum shining; postscutellum large; area of metathorax not very large, wrinkled at base; tegulae red; wings hyaline, stigma red; basal nervure falling short of nervulus; first recurrent nervure meeting intercubitus; first tergite with a conspicuous band of white tomentum at each side before margin; broad margins of second and third tergites pallid with fine pubescence.

Gambia: Bathurst, March 3, 1911 (J. J. Simpson).

Perhaps this should go in *Nothylaeus*, but it is not typical of that genus. I wondered whether the uniform red color could be due to immaturity, but there is no evidence of this. Aside from the red color, which is unique, the markings suggest *Nothylaeus junodi* (Friese), though differing in detail; for example, there are light marks on the scutellum of *N. junodi*.

HYLAEUS PROTEAE, new species

Male.—Length 7.5 to 9 mm.; black with no red, and no spots on scutellum; clypeus shining black, with middle of upper part de-

pressed; face marks white; supraclypeal mark triangular, well developed; lateral face marks broad at level of upper end of clypeus, narrowed to an obtuse point above, below abruptly narrowed, and ending in a hooklike point next to upper part of clypeus, or coming to an acute angle below; scape enormous, globose, intense black, shining; flagellum dull orange beneath, black above; mesonotum and scutellum shining, well punctured; area of metathorax strongly wrinkled; collar white, but tubercles black; tegulae black, with a large white spot; wings hyaline, faintly dusky, stigma very dark brown; basal nervure falling short of nervulus; first recurrent nervure meeting intercubitus; legs black; abdomen with first two tergites shining, the third duller; margin of first tergite with white hair at sides; no dorsal tubercles, but third sternite produced into a large (but variable) flaplike structure.

Pondoland: Port St. John, 10 specimens (R. E. Turner).

The holotype is marked "on *Protea*, 1,200 feet," October 1923. All were taken in October, except one in January 1924. Related to *H. aterrimus* (Fries), but differing greatly in the structure of the abdomen. The face markings recall *H. uelleburgensis* Strand.

HYLAEUS NAMAQUENSIS, new species

Female (type).—Length about 6 mm.; black, the face all black except a large broadly triangular mark on each side at level of upper end of clypeus; flagellum red beneath; collar narrowly margined with white, but tubercles black; hind tibiae with a large yellowish-white mark near base; front tibia reddish in front, and with a pale spot at base; second and following tergites with bands of pure white hair. Head broad; clypeus strongly punctured, conspicuously shining at sides; mesonotum and scutellum polished and strongly punctured; postscutellum shining, but metathorax entirely dull; tegulae subhyaline, with a light spot; wings clear hyaline, stigma and nervures brown; basal nervure meeting nervulus; first recurrent nervure meeting intercubitus; abdomen shining, first tergite duller and strongly punctured, contrasting with the second.

Male.—Length about 5.5 mm.; more slender; labrum and mandibles black, but face entirely lemon yellow, with a large and very long supraclypeal mark, and broad lateral marks ending very obtusely about halfway up sides of front; scape with a slight spot at end; basitarsi white, and small joints pale reddish; tubercles black as in the female.

South-West Africa: Aus, January 1930, 11 females, 10 females (R. E. Turner, 10).

Compared with *H. curvilinearatus* (Cameron) the male has the lateral face marks much broader above, and the supraclypeal mark much longer. *H. promontorii* (Meade-Waldo) and *H. alfkeni* (Friese) have the female face all black.

HYLAEUS FLAVISCUTUM (Alfken)

H. van Cockerell, 1936, is the male of this species.

Turner collected nine females and five males at Aus, December 1929, and a female at Aliwal North, January 1923.

HYLAEUS IMMARGINATUS (Alfken)

Lion's Head, Cape Town, both sexes, May 1920 (Turner).

Two of the males have the light color of clypeus extending above the inner level of lateral marks, thus simulating a supraclypeal mark. Apparently this is only a variety.

HYLAEUS MELANOSOMA (Cockerell)

Pondoland: Port St. John, May, June, July, August, December, 1923 (R. E. Turner).

Described from Durban and Knysna; Port St. John is between these localities.

HYLAEUS PERATER (Cockerell)

This was described from Tshibinda, Belgian Congo, but was also taken in South Rhodesia.

The following description is based on specimens from Abyssinia, and gives details concerning the structure of the male, not given in the original account.

Male.—Length about 5.5 mm., anterior wing 4.7; entirely black, including legs, antennae, and tegulae; wings dilute brownish, clear at base, stigma dark brown; face broad, but eyes strongly converging below; clypeus long, strongly punctured, narrowed above; scape strongly swollen and highly polished; mesonotum minutely punctured, dull, a little shining on disk, and with three short shining lines; scutellum well punctured, shining; postscutellum large, with a few long hairs at each side; area of metathorax with strong wavy rugae; posterior truncation dull, with a cuneiform shining area in middle; basal nervure falling a little short of nervulus; first recurrent joining apical corner of first cubital cell; abdomen dullish, very

minutely punctured, with a marginal fringe of white hair, not always present, at sides of first tergite. The black of the abdomen seems to have a slight bluish tint, so slight as to be possibly illusory.

Female.—Somewhat larger and more robust, the scape normal; flagellum very faintly brownish beneath.

Abyssinia; two males and a female. Donated by R. E. Turner, but evidently not collected by him.

HYLAEUS SIMULANS, new species

Female.—Length nearly 7 mm.; black, with white markings as follows: narrow lateral bands along orbits, a small spot in middle of lower part of clypeus in holotype, but not in the others, continuous band on collar, and spot on tegulae; tubercles black, the margin ciliate; wings dusky, basal nervure falling a trifle short of nervulus, first recurrent meeting intercubitus. This is part of Turner's No. 7, which also includes *H. microstictus*. The two species do at first sight seem to be very much alike, but the present insect lacks the clypeal pit and has a narrower face. As in *H. microstictus*, the front tergite is very minutely punctured. The clypeal spot suggests *H. immarginatus* (Alfken), which differs at once by the black collar, and the distinctly shining mesonotum, with strong well-separated punctures.

Cape Province: Mossel Bay (type locality), six, March 1922, March-April 1932, April 1933 (R. E. Turner); Katberg, 4,000 feet, November 14-26, 1932 (Turner).

HYLAEUS SUBREDITUS, new species

Female.—Length about 6.7 mm.; black, robust, with a large transverse shining clypeal pit; no light markings anywhere, except short lateral marks next to orbits at level of antennae, and a small spot on tegulae; wings dusky. In almost all respects this agrees with *H. redivus* Cockerell; it has the first tergite excessively minutely and closely punctured, and a conspicuous line of white hairs sublaterally on margin of first and second tergites. It is larger and more robust than *H. redivus*, and the mesonotum and scutellum, seen from above, are entirely dull, whereas in *H. redivus* the sides of disk of scutellum, and corresponding areas on hind part of mesonotum are polished and shining. The sides of the metathorax are dull.

Cape Province: Somerset East, November 1930 (R. E. Turner, 12).

In addition to the type, there is another like it, and a third, smaller, specimen, with clearer wings. This last looks much more like *H. reditus*, but it is not that species, and for the present I regard it (as did Turner) as a variation of *H. subreditus*.

Turner has given the same number (12) to a male from Somerset East, November 1930, and I accept it as the male of *H. subreditus*, without any more proof than the general similarity, the identical date, and Turner's opinion. It is about 5.5 mm. long, with dusky, highly iridescent wings. In my table in American Museum Novitates, No. 847, p. 9, 1936, it runs to *H. abjunctus* Cockerell, having the face creamy white, and the hind tibiae black. The first abdominal sternite, seen in lateral view, shows a strong protuberance. From *H. abjunctus* it differs thus: inner corners of lateral face marks opposite middle of supraclypeal mark; flagellum very obscurely reddish beneath; mesothorax and scutellum hardly shining, the punctures not evident under a lens; basitarsi not white. The basal nervure nearly meets the intercubitus, and the first recurrent joins the first cubital cell near the end. The tegulae are entirely black, the scape is swollen, but not excessively so, and is very finely punctured at upper end. The microscope shows the mesonotum to be strongly, extremely densely, punctured, the punctures tending to run in transverse lines. If this is *H. subreditus*, it appears to belong with the smaller variety, which it superficially resembles very closely.

HYLAEUS XANTHOSTOMA (Alfken)

Female.—Length about 5 mm.; slender, black, with the clypeus and the region of the mouth red, not yellow as the name given by Alfken would imply. The type locality is Sunday River in South Africa. Turner took six females at Okahandja, December 1927 and March 1928. The same species has been reported from the Belgian Congo and Nigeria. The male is described from Stanleyville; no South African males have been seen. One female was taken by Turner at Umtata, Transkei, February-March 1923. This has an altitude of 2,300 feet.

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DEVELOPMENTAL PHYSIOLOGY OF THE GRASS SEEDLING

I. INHIBITION OF THE MESOCOTYL OF AVENA SATIVA BY CONTINUOUS EXPOSURE TO LIGHT OF LOW INTENSITIES

(WITH ONE PLATE)

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INTRODUCTION

It is well known that growth of the mesocotyl of various grass seedlings is markedly influenced by illumination. Nevertheless, our understanding of the mechanism of this phenomenon is very fragmentary, despite the numerous studies that have been made since the effect was first noted by Cassini (1820) more than a century ago. One of the many aspects of the problem about which further quantitative information is desirable is that of the spectral effectiveness of the radiant energy causing the growth inhibition. The present experiments have been undertaken as a first approach toward the determination of the action spectrum for mesocotyl inhibition.

Review of the literature¹ leads to the conclusion that, in general, there has been inadequate appreciation of the dependence of the effects of radiant energy upon its intensity and spectral distribution, upon the duration of the irradiation, upon the developmental stage of the plant and possibly also upon other environmental and internal conditions. The present report is concerned exclusively with the results produced by light of known intensity and quality, applied throughout the entire period of growth of the mesocotyl. As far as the authors are aware the only comparable published experiments are those of Avery, Burkholder, and Creighton (1937).

EXPERIMENTAL PROCEDURE

Oats of the variety Markton² were used. After removal of the glumes the dormant grains were planted individually in small test

¹ An analysis of the literature relating to the physiology of the grass mesocotyl is being prepared for separate publication.

² The seeds were kindly supplied by T. R. Stanton, of the U. S. Department of Agriculture.

tubes (about 1 cm. in diameter and 7 cm. long) on slants of 1 percent agar made up with tap water. The seeds rapidly absorb water from the agar, and the seedlings develop very uniformly. This technique is convenient for irradiation studies in that the seeds, which have been found to be insensitive to light during the first few hours of germination, can be placed in the desired experimental environment within a few minutes after planting. No further attention or manipulation of the plants is required until the conclusion of the experiment when the seedling organs are measured. An 8-day growth period was chosen,

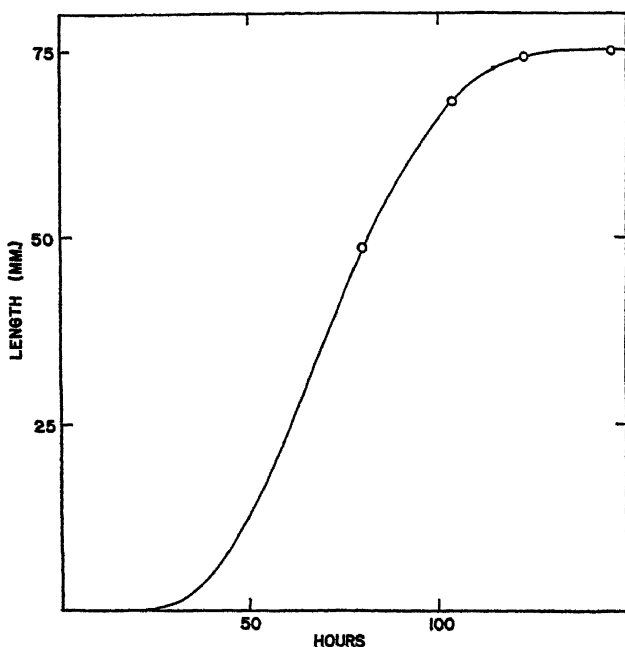


FIG. 1.—Growth curve of mesocotyl in complete darkness at 27.5° C.

since at the temperature used the mesocotyl and coleoptile have completed their growth in this length of time (see fig. 1).

The growth chamber consisted of a galvanized iron box divided into 4 compartments into each of which was placed a set of 25 to 30 culture tubes in a 400-ml. beaker. A layer of water on the floor of the growth chamber served to maintain the humidity of the air at saturation. The open top of the box was provided with flanges so that each compartment could be covered with an individual filter, without the light passing from one compartment to another. In practice three different light intensities were studied in a single experiment, the fourth group of plants serving as a dark control.

In order to provide a graded series of intensities at each wave length, light screens were made up of layers of colored cellophane enclosed between two sheets of glass. Various colors of cellophane are available and by choosing the appropriate number of layers almost any desired series can be obtained. The transmissions of these filters were determined for the particular spectral bands in which they were employed.

The spectral regions studied were isolated by means of two quartz-prism monochromators arranged in series. The wave-length spread of these bands was determined visually with a spectroscope.

The radiation source was a 1,000-lumen, 6.6-ampere Mazda street-series lamp operated from a 115-volt a.c. line, through a transformer, at 18 volts and 6 to 7 amperes. Line-voltage fluctuations were minimized by means of a voltage regulator. Gradual drifts in current due to ageing of the lamps could be detected by a sensitive ammeter connected in the circuit; this was read several times during each day and, when necessary, the current was adjusted by means of a variable resistor. The variation in current was never greater than a few hundredths of an ampere during a day and in many experiments no change could be observed over a period of several days.

The lamp was placed outside the dark room containing the growth chamber and the double monochromator so that only the radiant energy which passed through the instrument reached the plants. The beam of light from the exit slit was reflected downward onto the seedlings by means of a 45° silvered glass mirror.

The box containing the plants was mounted on a turntable rotated by a synchronous motor at 2 revolutions per minute, so that each set of plants traversed the light beam 4 times each minute. The rotation was considered necessary since the two sides of the box received light of slightly different wave-lengths owing to the widths (85 to 130 Å.) of the bands isolated.

The intensities incident on the plants were calculated by means of the inverse-square law. This is justified since, at the distances used, the exit slit (1 by 10 mm.) can be considered as a point source without significant error. The relation between the intensity at the slit and that at 10 cm. distance from the slit was determined initially; from the values of this factor, of the length of the light path from the exit slit to the seeds, of the reflection loss due to the mirror and of the transmission of the filters, the intensity at the level of the seeds could be calculated. It is realized that an error is introduced through the use of vertical illumination, since, owing to the growth of the shoots, the effective intensity changes slightly during the course of the

experiment and is actually somewhat greater than that at the seed level. This error is smaller than the uncertainties in other measurements, however, and may be neglected.

Except for the experiments at 6600 Å., the radiation intensity at the exit slit was measured by a vacuum thermocouple connected with a Leeds and Northrop type-HS galvanometer. The thermocouple and galvanometer combination were calibrated against a National Bureau of Standards standard of radiation, correction being made for the differences in wave-length distribution of the standard lamp and of the spectral regions isolated by the double monochromator. For the experiments at 6600 Å. a barrier-type photocell ("Electro-

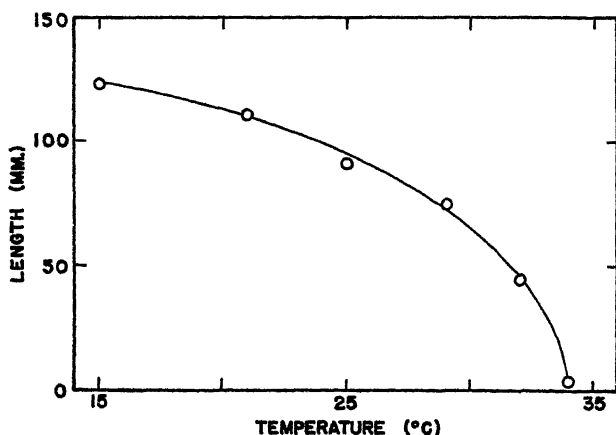


FIG. 2.—Influence of temperature on final lengths of mesocotyls grown in complete darkness.

cell") and high-resistance galvanometer, which had been calibrated against the thermocouple at this wave length, were used.

The relationship between the effects of temperature and of radiant energy on the development of the grass seedling is a subject that would appear to justify detailed investigation. Some preliminary results of such a study, shown in figure 2, emphasize the necessity of close control of temperature if comparisons are to be made among plants grown at different times. As a check on the adequacy of the temperature regulation in the present work a continuous thermograph record was obtained for each run. In the majority of these experiments the temperature was maintained at $27.5 \pm 0.2^\circ \text{C}$. In a few the temperature varied from this value over a 1- to 2-degree range. For this reason the length measurements of the plants in all the experiments are not strictly intercomparable. However, since there is no

evidence that the action spectrum is affected by small temperature differences, the values relative to the dark controls included in each run are comparable. The results, therefore, have been expressed in relative terms.

RESULTS

The mesocotyls of seedlings that are illuminated continuously from the time of planting do not attain as great a final length as do those grown in darkness. The extent of the growth inhibition is dependent upon the intensity and quality of the light. The results for a series of wave-length bands are summarized in table 1. These data are plotted in figure 3, using a logarithmic scale for the intensities; the curves were fitted by the method of least squares.

It will be seen that the inhibition is proportional to the logarithm of the intensity and that the slopes of the curves for different wave lengths are substantially equal. The curve for 7700 Å. has been arbitrarily drawn parallel to the others since only the highest intensity employed was sufficient to cause measurable inhibition. Attention should be directed also to the great range of intensities over which the inhibitory effects are produced and to the existence of distinct threshold values for each wave-length band.

The action spectrum is obtained by plotting the reciprocal of the intensity required to produce a given effect against the wave length. On the assumption that the number of quanta required for this response is the same at all wave lengths, comparison is more properly made on a quantum basis. This has been done in figure 4, although the correction is relatively small (table 2). The action curve shows a sharp peak at about 6600 Å. and indication of a second maximum in the neighborhood of 6200 Å.

DISCUSSION

The experiments here reported were undertaken to furnish a working curve as a basis for further investigation. The present results are to be regarded as constituting merely a first approximation to the action spectrum for mesocotyl inhibition since data are available for only seven relatively widely spaced wave lengths. Although these points have been connected by a curve, it is obvious that nothing is actually known of the intermediate regions. Other methods of study which are less time-consuming can be employed to obtain additional points on the curve and it is hoped to present the results derived by such technique at a later date.

TABLE I.—*Light intensity and mesocotyl inhibition*

Wave-length band (A.)	Intensity at seed (ergs/mm ² /sec)	Inhibition (%)
4250-4360	618,000. $\times 10^{-1}$	66.9
	59,000.	45.7
	11,200.	30.1
	8,520.	33.2
	1,070.	5.4
	154.	0
	19.2	0
	2.78	0
5445-5552	78,000.	61.6
	75,700.	60.6
	22,000.	47.5
	21,300.	49.3
	13,100.	48.1
	6,200.	38.9
	6,010.	39.4
	3,950.	33.8
	1,120.	20.0
	1,040.	22.3
	312.	9.4
	82.6	0
	6.84	0
6155-6240	20,600.	67.3
	4,810.	60.3
	1,450.	46.9
	337.	33.1
	101.	23.7
	23.6	6.6
6435-6550	3,720.	57.6
	3,200.	59.7
	192.	30.1
	166.	29.6
	10.1	3.9
6545-6645	4,450.	69.2
	4,360.	68.7
	1,600.	62.0
	788.	57.0
	234.	43.4
	230.	44.8
	84.2	30.0
	41.6	26.6
	4.43	5.8
7030-7160	2,300.	66.9
	858.	35.4
	32.2	4.5
7640-7760	74,000.	11.0
	7,250.	0
	708.	0

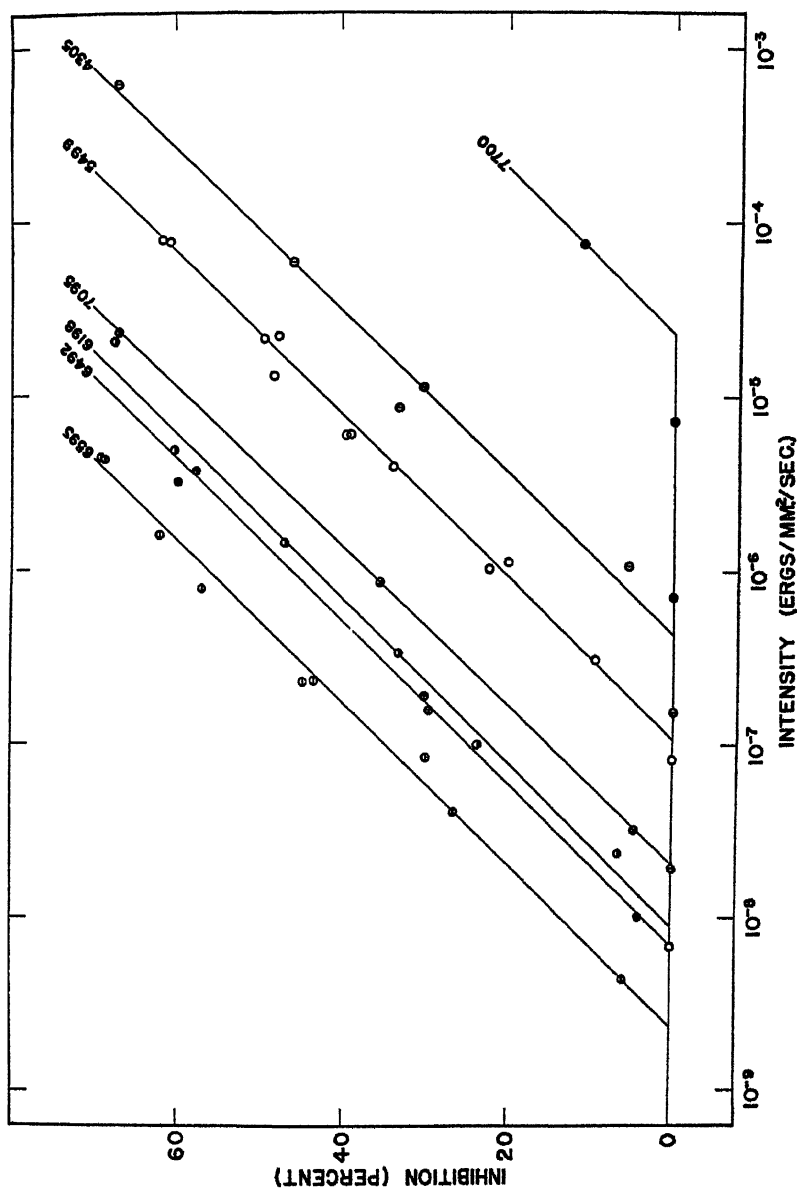


FIG. 3.—Effect of intensity on inhibition of mesocotyl growth by various wave lengths of light.

The true position of the peak shown at 6600 Å. may possibly be at a somewhat longer wave length. There is some uncertainty also as to the exact location of the suggested second maximum.

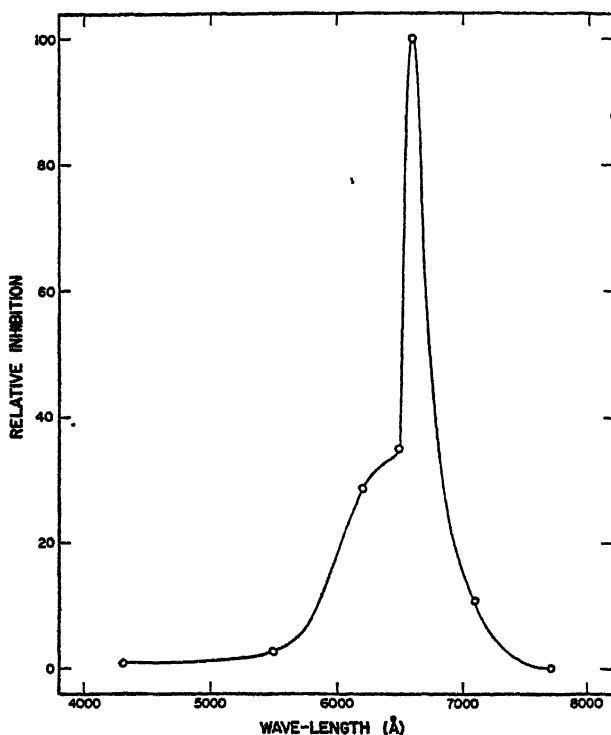


FIG. 4.—Spectral effectiveness curve for mesocotyl inhibition.

TABLE 2.—*Relative spectral effectiveness for mesocotyl inhibition*

Wave length (Å.)	Relative effectiveness	
	(Compared on energy basis)	(Compared on quantum basis)
4305.....	0.6	0.8
5499.....	2.2	2.4
6198.....	26.7	28.4
6492.....	34.0	34.5
6595.....	100.	100.
7095.....	11.6	10.8
7700.....	0.01	0.009

The absorption spectrum of the photoreceptive substance involved in the inhibition of growth by light may be expected to show a general resemblance to the action spectrum, provided that other pigments are

not present also. Since marked growth effects may be obtained by illumination of dark-grown seedlings for periods of only a few seconds, the light-sensitive system appears to be present in the completely etiolated seedling. Extracts of etiolated oats seedlings show absorption bands with maxima at about 625 and 660 $m\mu$. Corresponding bands, at somewhat longer wave lengths, can be observed also on first illumination of etiolated oats leaves. Preliminary study has indicated that these bands are due to at least two substances; these might conceivably be the pigments which have been designated as protochlorophyll and chlorophylligen. It is not possible to state, as yet, whether more than one pigment participates in the photoreceptive mechanism of mesocotyl inhibition.

The dark-grown oats seedling contains also relatively large amounts of carotenoid pigments which absorb strongly in the blue portion of the spectrum, where the provisional action spectrum shows no maxima. However, since the absorption by these yellow pigments might be expected to diminish the effectiveness of the shorter visible wavelength region and since the mesocotyl growth is in fact affected by light of such wave lengths, it seems very likely that the photoreceptive pigment possesses absorption bands in this region also.

The growth of the mesocotyl in darkness is the result of two processes: cell division and cell elongation. The data of Avery, Burkholder, and Creighton (1937) suggest that at low light intensities it is the process of cell multiplication that is inhibited, whereas cell elongation is affected only by higher intensities. If experiments such as those reported above are extended to higher intensities a more or less sharp inflection is found in the inhibition-intensity curves. It may be inferred that at intensities below this knee (i.e., for the region shown in the curves of figure 3) only cell division is influenced, whereas at higher intensities inhibition of cell stretching is involved also. Experiments designed to furnish cytological evidence bearing on this suggestion are now in progress. If the mechanism should prove to be as outlined the action spectrum determined at the lower intensities represents chiefly the inhibition of cell multiplication. It might be possible, by studies at higher intensities, to determine also the action spectrum for the cell-extension process.

The authors take pleasure in acknowledging the cooperation in many ways of the other members of the Division of Radiation and Organisms and the technical assistance of E. R. Brydon and O. R. Zipf during part of this investigation.

SUMMARY

1. The relationship between growth inhibition of the mesocotyl of *Avena sativa* and the intensity of the radiant energy causing it has been determined for a number of relatively narrow wave-length bands in the visible spectrum. At low intensities the inhibition is proportional to the logarithm of the intensity.

2. From these data a provisional action spectrum of mesocotyl inhibition has been plotted. This shows a single peak at approximately 6600 A. and an indicated secondary maximum in the neighborhood of 6200 A.

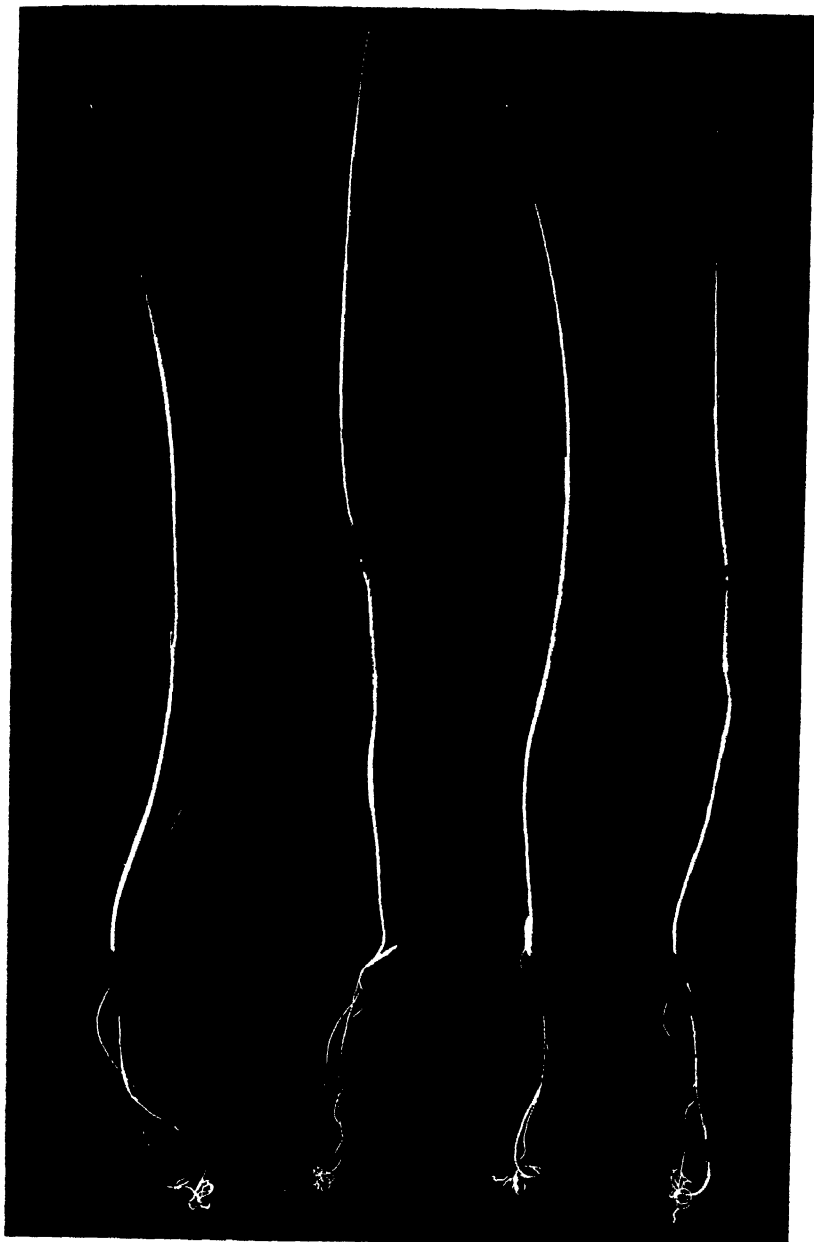
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REPRESENTATIVES OF FOUR SERIES OF SEEDLINGS OF *AVENA SATIVA*
GROWN UNDER VARIOUS LIGHT INTENSITIES

The apical limit of the mesocotyl is indicated by the adventitious roots at the coleoptilar node.

